AN ABSTRACT OF THE THESIS OF

Cara McCulley Kelly of the degree of Master of Arts in Interdisciplinary Studies in Anthropology, Anthropology, Geography presented on June 11, 2001. Title: Prehistoric Land-Use Patterns in the North Santiam Subbasin, On the Western Slopes of the Oregon Cascade Range.

Abstract approved: Redacted for Privacy

Barbara Roth

This thesis examines prehistoric land use patterns of the entire North Santiam subbasin, located on the western slopes of the Oregon Cascade Range. The objective of this analysis is three-fold: 1) to contribute to reconstructing the cultural chronology of the area; 2) to address the use of raw material by local hunter-gatherers and how raw material can be used to reconstruct the seasonal procurement ranges for these groups; and 3) to model the adaptive strategies of the prehistoric inhabitants of the North Santiam subbasin.

The adaptive strategies of hunter-gatherer groups in the North Santiam subbasin are addressed by using the known ethnographic record, limited archaeological excavations, and the environmental and social data layers in Geographic Information Systems. ArcView Spatial Analyst was used to analyze the density and distribution of prehistoric sites and their association with major vegetation, huckleberry patches, non-forested communities, slope, aspect, streams, lithic sources, hot springs and trails within the subbasin. Five elevation zones are outlined corresponding to the site density pattern and the key predictive environmental and social variables. This study assumed that sites are not randomly distributed across the landscape; instead hunter-gatherer groups chose a particular location based on the natural environment. It is also assumed that many of the environmental variables have survived to modern time and are represented by the presently available data.

Concurrent trace element analysis by X-ray fluorescence spectrometry and obsidian hydration analysis conducted on projectile points recovered from the surface and

subsurface have provided evidence for early occupation in the subbasin; and revealed patterns in mobility, social interaction, and the use of raw material during the Archaic.

The key predictive variables sustained a diversity of plant and animal resources that attracted human groups from both east and west of the Cascade Mountains over the past 10,000 years to seasonally hunt and procure a variety of important plant resources. The results of this study while descriptive in nature elucidates a pattern of land-use by hunter-gatherers, by providing key distributional data on prehistoric sites and their association to particular ecological zones within the North Santiam subbasin during the Archaic Period.

Prehistoric Land-Use Patterns In
The North Santiam Subbasin
On the Western Slopes of the Oregon Cascade Range

By

Cara McCulley Kelly

A THESIS

Submitted to

Oregon State University

In partial fulfillment of
The requirements for the
Degree of

Master of Arts in Interdisciplinary Studies

Presented, June 11, 2001
Commencement June 2002

Master of Arts in Interdisciplinary Studies thesis of Cara McCulley Kelly presented on June 11, 2001.

APPROVED:

Redacted for Privacy

Major Professor, representing Anthropology

Redacted for Privacy

Committee Member, representing Anthropology

Redacted for Privacy

Committee Member, representing GeoSciences

Redacted for Privacy

Chair of Department of Anthropology

Redacted for Privacy

Dean of Graduate School

I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature authorizes release of my thesis to any reader upon request.

Redacted for Privacy

Cara McCulley Kelly, Author

ACKNOWLEGMENTS

I wish to express sincere thanks to my committee members: Barbara Roth, David Brauner and Ron Doel. In particular, I would like to express my appreciation to Barbara Roth for her continued guidance, comments, suggestions and encouragement. She was always available to address any of my concerns or questions during my years at Oregon State University.

I would like to thank the Willamette National Forest for making this project possible by contributing the data set for this research and access to ArcView. There are numerous employees of the Willamette National Forest, especially at the Detroit Ranger District, who provided assistance, advice, and encouragement over the past several years. In particular, I would like to extend my deepest gratitude to Diana Walker and Dean Mills for their immeasurable patience and encouragement. They contributed their time, advice and technical expertise, and were always willing and available to answer my string of endless questions. I am forever grateful for their unwavering support during this project.

I would also like to thank Eric Bergland, who reviewed several chapters in very rough draft format and provided much needed encouragement and advice on the technological section of this thesis. Cathy Lindberg, Mike Roantree, Dave Leach, Rosanna Costello, Nora Holmquist, and Jim Romero all contributed to varying degrees technical advice and comments. I wish to extend my thanks to Felicia Rounds Beardsely for mentoring me during my first couple of years working as an archaeologist for the U.S. Forest Service, along with her continued support after she moved on to pursue other career opportunities.

The Oregon Laurels Graduate Scholarship provided financial assistance for the cost of tuition.

Most importantly, I am forever indebted to my Irish husband and companion, Clare Patrick Kelly, without whom I would never have made it through the many challenges of balancing a full-time job, school and home. His unwavering confidence in me, as well as his support on the home front during my graduate studies, made this thesis possible.

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED).

TABLE OF CONTENTS (CONTINUED).

TABLE OF CONTENTS (CONTINUED).

LIST OF FIGURES

LIST OF FIGURES (Continued).

LIST OF FIGURES (Continued).

LIST OF FIGURES (Continued).

LIST OF TABLES

LIST OF TABLES (Continued)

PREHISTORIC LAND-USE PATTERN IN THE NORTH SANTIAM SUBBASIN, ON THE WESTERN SLOPES OF THE OREGON CASCADE RANGE.

CHAPTER 1
INTRODUCTION

This thesis examines prehistoric land use patterns of the entire North Santiam subbasin, located on the western slopes of the Oregon Cascade Range. The objective of this analysis is three-fold: 1) to contribute to reconstructing the cultural chronology of the area; 2) to address the use of raw material by local hunter-gatherers and how raw material can be used to reconstruct the seasonal procurement ranges for these groups; and 3) to model the adaptive strategies of the prehistoric inhabitants of the North Santiam subbasin by determining which environmental and social strategies were important to them when deciding where to place a site in the physical environment. Addressing these three objectives will help guide land management decisions in the protection of cultural resources and contribute to the local and regional prehistory.

The North Santiam subbasin was chosen as the study area for several reasons. First, over the past 12 years intensified survey coverage in this subbasin has uncovered over 200 new prehistoric sites. Coupled with this increase in recorded sites, the Detroit Ranger District has developed a comprehensive Geographic Information Systems (GIS) with extensive data on vegetation, lakes, ponds, rivers, streams, marshes, mires, meadows, slope, aspect, prehistoric site locations, artifacts, and cultural resource surveys that have been conducted for the entire subbasin. Second, most of the studies on land-use for the Central Cascades have been conducted to the south of the North Santiam subbasin in the Upper Middle Fork of the Willamette subbasin, and to the north in the region surrounding Mount Hood. Third, it is often thought that the natural subbasin boundaries may have also been boundaries for cultural groups.

To illustrate the first two objectives, concurrent obsidian hydration and sourcing analysis are conducted on the Western Stemmed, Foliate, Dart, and Arrow projectile points collected from the North Santiam subbasin. The results reveal a general decrease in the mean hydration values in each obsidian type as one moves downward in order. The Western Stemmed projectile point is considered a better chronological indicator for identifying early occupation in the western Oregon Cascade Mountains than the "Cascade" point. Changes in raw material procurement suggest the possibility of contact with more southerly groups, or extended mobility with the introduction of the horse.

To address the adaptive strategies of the prehistoric occupants, applicable portions of three land-use models proposed for this region are tested (Baxter 1986, Snyder 1987, and Burtchard 1991). Burtchard, Snyder, and Baxter's models address several variables that are important for understanding what resources were available to groups and the choices they made when deciding to select a particular site location. The main focus of these models is on the physical strategies and critical resources crucial for population survival.

In testing the models, three sources of information are used: 1) the known ethnographic record; 2) limited archaeological excavations; and 3) the available data layers in GIS. ArcView Spatial Analyst (a product of ESRI Corporation) is used to analyze the density and distribution of prehistoric sites and the locational relationship of these sites with the environment and with each other.

Prehistoric land-use models are often based on the assumption that the environment shapes where humans settle. This assumption is almost always implicit in these models. In modeling site location, it is important to understand which environmental and social features affected the decision to settle in a particular location. The occurrence in a single location of more than one critical resource (e.g. huckleberries, large game, non-forested environments or along a transportation route) increases the likelihood of use and reuse for that particular location.

Hunter-gatherer populations in the Cascade Mountains and surrounding regions were dependent on the natural environment to sustain their lifeways. Using mobility and an effective tool kit, they had the ability to form an adaptive system to contend with seasonal changes in the location of food resources. As humans became aware of their physical environment, it is likely that familiar surface features guided their travels and established their procurement range.

Within the western slopes of the Oregon Cascade Range, and more specifically the North Santiam subbasin, the topography and climate patterns associated with elevation gradients have a direct bearing on the hydrology and diverse distribution of plant species and terrestrial and aquatic faunas (Franklin and Dyrness 1988). Spread unevenly across the elevation ranges of the North Santiam subbasin, hunter-gatherer groups needed to possess the knowledge to accurately predict the availability of a particular resource on the landscape, based on the season and location, without the need to monitor. Hunter-gatherer groups would have played an important role in shaping the ecology of the landscape to meet their subsistence needs. Hunting, wild food gathering, and the use of fire to promote plant resources, game habitat and travel in the forested environment would have impacted the ecology of the forested environment. The natural and social environment of any adaptive system is always changing. To understand these changes, ancient environmental change, cultural adaptations, and shifts in human settlements on the natural landscape over long periods of time must be understood.

This thesis is organized into eight chapters. The following chapter presents an overview of the site-related environment within the western slopes of the Oregon Cascade range and more specifically the North Santiam subbasin. Chapter Three presents an overview of the relationship between the ethnographic record and the history of archaeological work conducted in the Cascades. Chapter Four provides data on projectile points collected from the North Santiam subbasin and associated obsidian sourcing and hydration analysis. Chapter Five discusses the three Cascade land-use models (Baxter

1986, Snyder 1987, and Burtchard 1991), Chapter Six discusses the archaeological field and GIS methods, Chapter Seven presents the results of the GIS analysis, and Chapter Eight provides the conclusion and recommendations.

CHAPTER 2
ENVIRONMENTAL SETTING

Environment

Because the environment played such a crucial role in land-use, this chapter discusses the environmental characteristics of the western slopes of the Oregon Cascade Range, and more specifically the North Santiam subbasin. The purpose of this section is to put into perspective what resources hunter-gatherer groups may have encountered over the last 10,000 years as a prelude to subsequent discussions of aboriginal land-use patterns. Schermer and Tiffany (1985:220 c.f. Dalle Bona) explain the importance of understanding local vegetation patterns and how these patterns relate to human adaptation.

> From the standpoint of human adaptation, patterns of local vegetation are of crucial concern. Many plants serve as primary food and technological resources as well as secondary resources which attract economically important animals. The distribution of non-food resources, especially water and fuel, can be equally important to settlement decisions. Diversity is also beneficial when considering non-food resources. In addition to fuel, a variety of trees provide the raw materials for tools, utensils, shelter, and weapons, pitch for sealing seams, and fibers from the inner bark for cordage, bags, and nets. A variety of plants can be used to make dyes, reeds can be woven into mats, and clay from local stream banks can be made into pottery. Evaluations of topography, water, soils, vegetation, precipitation, temperature, and availability of rock outcrops

or glacial till exposures are all important in decisions about the adequacy of shelter and the availability of economic resources.

Geology and Physiography

The western slopes of the Oregon Cascade Range are a dendritic drainage system that has developed on slightly folded and partially altered Tertiary volcanic rocks (Peck et al. 1964:3). The entire Cascade Range extends for over 625 miles from northern California into British Columbia, Canada. In the North Santiam subbasin and the western Cascades in general, water is abundant at all elevations in springs, streams, and lakes, although there are some areas where water availability is limited due to either seasonal variations in stream flow or local depositional conditions. The extensive watershed of the North Santiam subbasin drains the western slopes of the Cascades, creating a roughly dissected topography. The western Oregon Cascades are composed of two distinct physiographic regions: the High Cascades and the Western Cascades (Figure 1; Franklin and Dyrness 1988).

In the North Santiam Subbasin, the Western Cascade province encompasses elevations ranging from 900 to 5000 feet (Figure 1). It makes up approximately two-thirds of the subbasin and includes the geologically much older foothill region, which is deeply dissected by numerous drainage systems and their associated tributaries. Cliffs, gorges, lakes, waterfalls, and pinnacles typically characterize these older eroded landforms. According to Baldwin (1976), the headwaters of these streams roughly correlate with the division between the High Cascades and the Western Cascades. Franklin and Dyrness (1988) report that Oligocene and Miocene volcanic activity deposited the oldest flows of basalt and andesite, as well as tuffs, breccias, and pyroclastics.

Figure 1: High Cascade and Western Cascade Provinces, North Santiam Subbasin.

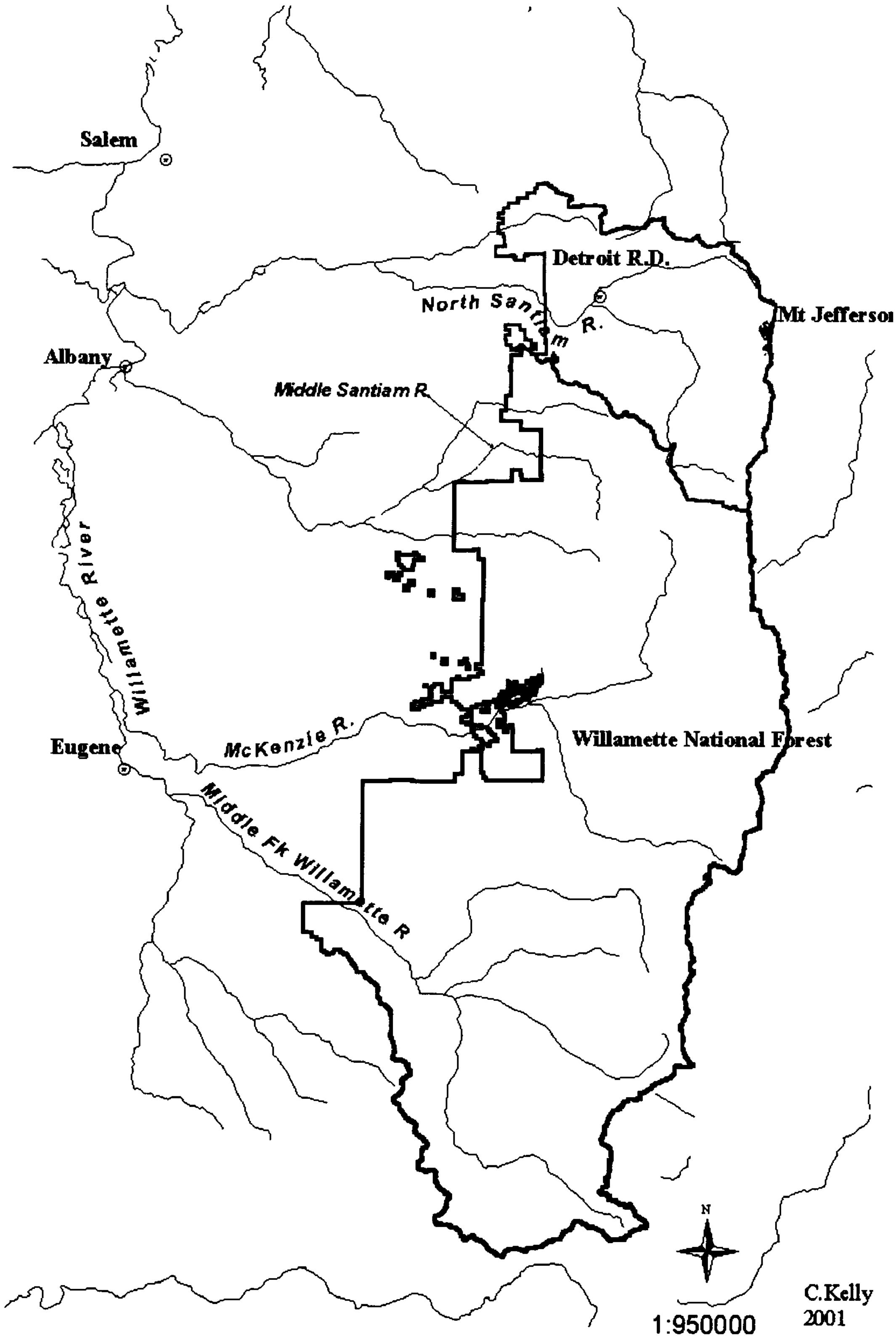
The High Cascade Province is located within the eastern one-third of the subbasin immediately adjacent to the crest of the Cascades (Figure 1). Elevations range from a low of 3000 feet along the western margins to a high of 10, 495 feet at the peak of Mount Jefferson. The province is composed of geologically young lava flows marked by a series of volcanic peaks that extend from Mount Jefferson on the northern end to Three Fingered Jack on the southern end. The upper reaches of major drainages along the western slopes of the Cascades were glaciated during the Pleistocene as evidenced by their U-shaped valleys and localized deposits of glacial drift (Franklin and Dyrness 1988:24). Glacially formed lakes and cirques are common throughout the High Cascade province and alpine glaciers are present above 8000 feet on Mount Jefferson (Baldwin 1976; Sutton 1974).

Relief in the High Cascade Province is less than in the Western Cascade Province. Glaciers have modified many of the peaks and have deepened and widened some of the major U-shaped valleys (Peck et. al. 1964). The U-shaped glaciated flat bottom valleys typically have steep rocky valley walls that abruptly transition to rolling uplands at higher elevations. These uplands commonly contain broad expanses of uniform, gently sloping topography with few live streams and little dissection. Slopes of 5 percent and less are common.

The Study Area

The study area encompasses the North Santiam subbasin, which lies 50 miles east of Salem, Oregon, along the western flanks of the Oregon Cascades (Figure 2). The North Santiam River, flowing through the middle of the subbasin, drains about 303,000 acres within the larger Willamette Basin. The subbasin is composed of five watersheds encompassing several tributaries that feed the North Santiam River, which in turn flows into the Santiam, the Willamette and Columbia Rivers respectively, before emptying into the Pacific Ocean. The Detroit Ranger District, the northern-most district on the Willamette National Forest, manages the area. The subbasin is bounded by three main

Figure 2: Vicinity Map



ridge systems to the north, east, and south, with the western boundary defined by State and Private land allocations. The following section describes the five watersheds within the subbasin.

Upper North Santiam Watershed

This watershed consists of 137,920 acres and is bordered on the west by the North Santiam River. The base of Three Fingered Jack on the Cascade crest is the source of the North Santiam River that generally flows in a south-north pattern making a right angled turn to the west at its confluence with Whitewater Creek (Shank 1997). The major ridge system is the Cascade crest along the eastern boundary. Mt. Jefferson, the most prominent feature on the District, is located to the north end of the ridge. The slopes of the mountain are bare of vegetation above 6,000 to 6,500 feet elevation (Sutton 1974). Between the densely forested lower elevations and the bare slopes of Mount Jefferson are a dense growth of subalpine vegetation; including snowbrush, manzanita, and huckleberries. At the mountain toeslopes are a series of meadows and glacially created lakes.

The southernmost boundary ends just prior to reaching State Highway 126. This area forms a broad expanse of gently sloping, low relief terrain that rises steadily to the east culminating in the sharp crags of Three Fingered Jack (Shank 1997). The southern portion of the watershed and district is defined by a series of large and small meadows and lakes. Elevation ranges from about 1,700 feet near the town of Idanha to 7,800 feet at Three Fingered Jack to the south, 10, 495 feet at Mt. Jefferson to the east, and 5, 400 feet at Triangulation Peak to the north. The Upper North Santiam watershed has the highest elevations and the highest precipitation ranging from 65-125 inches annually.

Detroit Tributaries Watershed

This watershed consists of 49,335 acres and includes the large Detroit Reservoir and surrounding landscape. Prominent features in the west and north include Monument Peak, Elephant Rock, Needle Rock, Dome Rock and Phantom Bridge. The peaks overshadow a moderately uniform landscape of jagged ridgelines that plunge for thousands of feet into numerous highly dissected draws to end on large gently sloping stream terraces along the North Santiam River and associated tributaries (Shank 1997).

Blowout Watershed

This watershed encompasses 34,000 acres and ranges in elevation from 1560 feet at Detroit Reservoir to 5771 feet at Coffin Mountain. The southwest boundary is defined by the Scar Mountain ridgeline that runs from Monument Peak in the northwest to Fisher Point in the southeast. This major ridge system divides the North Santiam and Middle Santiam river drainages. Nestled amongst the peaks and along the ridgeline and ancillary ridges are numerous dry/wet meadows and extensive huckleberry patches.

Breitenbush Watershed

This is the northeastern-most watershed encompassing 69,400 acres. The Breitenbush River flows westerly through the area emptying into the North Santiam River west of Piety Knob. The northern boundary of the area is defined by a ridge system that separates the Willamette and Mt Hood National Forests. This narrow ridgeline extends from Nasty Rock at the northwest end of the ridge to Bald Butte at the northeast end of the ridge where it opens into broad expanse of potholed lakes, ponds and marshes at the base of Olallie Butte, Potato Butte, Double Peaks and Rudy Hill. The ridgeline slopes drop dramatically to the north into the Clackamas and Little North Santiam, and south into Breitenbush River subdrainages. The broad stream valley along the

Breitenbush River provides an excellent travel route to the geothermal Breitenbush Hot Springs, an important feature used for thousands of years by prehistoric groups for medicinal purposes (Griffin 1985).

Little North Santiam Watershed

This watershed consists of 72, 157 acres of which 36,144 acres are on lands administered by the Detroit Ranger District. The Little North Santiam flows into the North Santiam River at the towns of Lyons and Mehama. This watershed originates at an elevation of 5569 at the top of Battle Ax Mountain and drops to an elevation of about 600 feet at the confluence of the North Santiam River. The streams in the upper elevations are confined to and consist of steep canyon and rock cliffs. Lower in the watershed the stream valley widens somewhat and the gradients decrease.

Modern Day Vegetation and Climate

The present-day diversity of vegetation and climate in the Pacific Northwest arises from the interplay between westerly maritime air masses and the north-south trending Coast and Cascade Ranges (Sea and Whitlock 1994). During the winters, the west side of the Cascades is exposed to numerous cool and wet weather systems that generate out of the Gulf of Alaska. Annually, the area receives an average of 65 inches of precipitation in the lower elevations to over 120 inches along the high ridges (Hemstrom et al. 1987). Most of the precipitation falls as snow in the upper elevations from November through April. Snow packs of 10 to 15 feet are common above 3500 ft and snow can remain in some areas well into the summer. The summer weather pattern is influenced by the east Pacific Subtropcial High pressure (Sea and Whitlock 1994). The summer months are generally extremely dry. In August the temperature usually reaches it highest, with a mean maximum temperature of 75 degrees F. to 63 degrees F. in the higher elevations (Hemstrom et al. 1987).

Figure 3: Watershed Boundaries, North Santiam Subbasin.

C.Kelly
2001

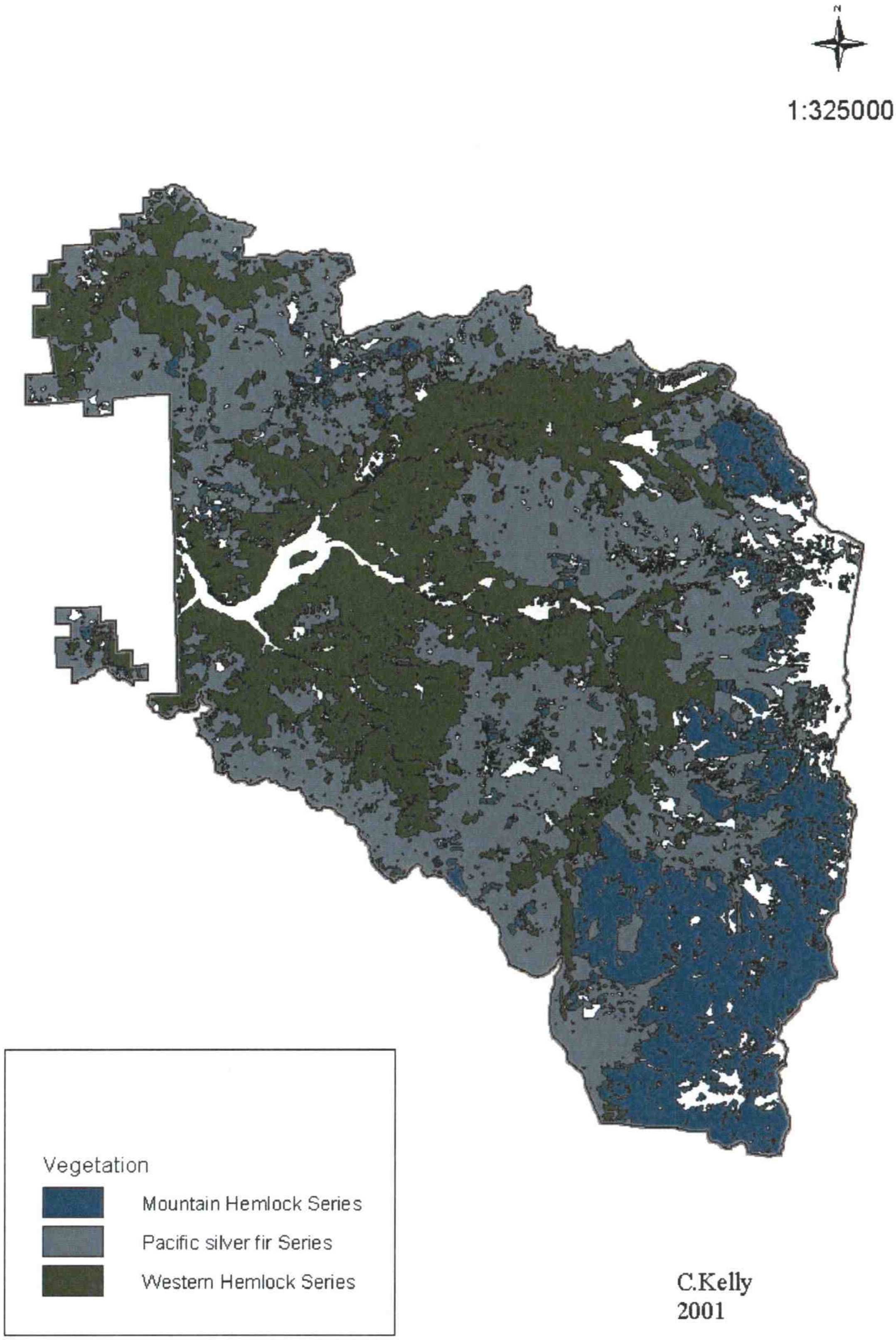
Within the subbasin, annual precipitation and temperature associated with elevation gradients have a direct bearing on the diverse distribution of plant species (Franklin and Dyrness 1988). The Native Indians relied on this diversity of plants as sources of food, materials used in technology, medicines, and for fuel.

Franklin and Dyrness (1988) have defined three major vegetation zones along the western flanks of the Oregon Cascades Range. In the North Santiam subbasin these include: (1) the *Tsuga heterophylla* (western hemlock) zone ranging from 400 (1310 ft) to 1200 m (3900 ft); (2) the *Abies amabilis* (pacific silver fir) zone ranging from 900 (2950 ft) to 1500 m (4900 ft); and (3) the *Tsuga mertensiana* (mountain hemlock) zone ranging from 1100 (3600 ft) to 2000 m (6500 ft) (Figure 4).

The *Tsuga heterophylla* zone is the most variable vegetation zone. Western hemlock, Douglas fir (*Psuedotsuga menziessii*), and western red cedar (*Thuja plicata*) are the major tree species, with western yew dotted across the zone (Franklin and Dyrness 1988). Grand fir (*Abies grandis*) and western white pine (*Pinus monticola*) also occur but are more restricted in range; Pacific silver fir (*Abies amabilis*) is found in the upper part of the *Tsuga heterophyllaa* zone. Understory habitats support swordfern (*Polystichum munitum*), vine maple (*Acer circinatum*), salal (*Gaultheria shallon*), devil's club (*Oplopanax horridum*), Pacific blackberry (*Rubus vitifolius*), mountain ash (*Sorbus sp.*), Oregon grape (*Berberis nervosa*), Pacific rhododendron (*Rhododendron macrophyllum*), and evergreen huckleberry (*Vaccinium ovatum*) (Franklin and Dyrness 1988:74; Hemstrom et. al. 1987).

In the *Abies amabilis* zone, pacific silver fir, western hemlock, noble fir (*Abies procera*), Douglas fir, western red cedar, and western white pine are the major tree species (Franklin and Dyrness 1988). Grand fir, lodge-pole pine (*Pinus contorta*), and Engelmann spruce (*Picea engelmannii*) are also seen throughout this zone. Understory species include evergreen violet (*Viola sempervirens*), common beargrass (*Xerophyllum tenax*), strawberry-leaf blackberry (*Rubus pedatus*), dwarf blackberry (*R.lasiocarpus*), big

Figure 4: Major Vegetation Series, North Santiam Subbasin.



huckleberry (*Vaccinium membranaceum*), grouse huckleberry (*v. scoparium*), (Franklin and Dyrness 1988: Hemstrom et. al. 1987)

Franklin and Dyrness (1988:101) divide the *Tsuga mertensiana* zone into two subzones. The mountain hemlock provides a continuous cover of the lower subzone forming a dense canopy. In contrast, the upper zone near timberline consists of patchy forest cover interspersed with shrubby or herbaceous subalpine vegetation (Sutton 1974). Alaska yellow cedar (*Chamaecyparis nootkaensis*), western white pine (*Pinus monticola*), noble fir (*Abies procera*) and subalpine fir (*Abies Lasiocarpa*) are some of the other tree species found within this zone. Understory plants include big huckleberry (*Vaccinium membranaceum*), grouse huckleberry (*v. scoparium*), manzanita (*Arctostaphylos nevadensis*), and mountain juniper (*Juniperus communis*) (Franklin and Dyrness 1988; Hemstrom et al. 1987). Another type of huckleberry, Cascade (*Vaccinium deliciosum*) grows mainly in Mount Jefferson Park near the base of Mount Jefferson and Hunts Cove in the Marion Lake Basin (Campbell 1973).

Non-Forested Communities

Dispersed across the three major vegetation zones are a series of non-forested communities. According to Hemstrom et al. (1987), stable non-forested communities are an indication of extreme environmental conditions such as extremely rocky substrates and extremely dry or wet areas.

As will be discussed in Chapter Four under Proposed Land-Use models, the following non-forested communities are considered critical resource gathering areas for hunter-gatherer groups. These open-forested communities make up a relatively small proportion of the North Santiam subbasin. Each of these diverse habitats has a complex and unique history, making generalizations about their formation and maintenance difficult (Messinger 1999). The resistance of conifer encroachment to meadow, and thus their long-term stability, has been contributed to a variety of factors including natural and human caused fires, browsing by faunal populations, heavy snow pack, landslides, and soil churning by rodents (Snyder 1987:57-61, Messinger 1999; Miller and Halpern 1998:265-282). Snyder (1987:60) notes "many if not most of these non-forested areas currently known in the Cascades represent environments established long ago, where rich plant communities—perhaps changing somewhat in species composition through time—maintained their integrity and importance as human resource areas down to the present."

A focus of the current research is to determine which, if any, of these non-forested communities served as important resource procurement areas in the North Santiam subbasin for past human groups. The following section provides a description of these non-forested settings and associated plants and wildlife. This information was gleaned from Dimling and McCain (1996:6-12 and 42,43) and Hemstrom et al. (1987:246-264).

Wet Habitats

Ponds

This type of habitat is a standing body of water that may be permanent or seasonal. The long-term maintenance of ponds is dependent on the water table, water quality and temperature. Wildlife associated with ponds and adjacent forest cover includes amphibians, turtles, fish, cavity-nesting waterfowl, feeding bats, violet green and tree swallows, otters/minks, elk, and beaver. Plants found within and on the edges of ponds include water lilies (*Nuphar polysepalum*), three-leafed buckbean (*Menyanthes*), and sedges (*Carex spp.*).

Bog (palustrine wetland)

This type of habitat is a permanently wet area dominated by sphagnum and other acid-tolerant plants. Wildlife associated with bogs and the adjacent forest covers are amphibians, beaver, feeding bats, and nesting shorebirds. Bogs are rare along the slopes of the western Oregon Cascades, especially in the North Santiam subbasin, due to the steep topography.

Plants common to this habitat are:

Scientific Name	Common Name
tofieldia	Tofieldia
Carex spp.	sedge
Vaccinium uliginosum	bog blueberry
Spiraea sp.	spirea
Habenaria sp.	bog orchid
Drosera rotundifolia	sundews
Kalmia	Kalmia

Swamp (palustrine wetland)

Swamps are permanent wet areas, often shaded by the forest canopy. There are three types of swamps located in the subbasin. 1) Skunk Cabbage is small in area and covered by the forest canopy; 2) Swamps are larger in area, open and often associated with western red cedar. Other plants in the area include vine maple, alder, skunk cabbage, devil's club, water hemlock and speedwell; and 3) Seeps or springs where the water table is at the soil surface. Amphibians are the main wildlife associated with these wetlands. Occasionally mineral deposits will occur at seeps creating salt licks for pigeons and elk.

Sedge Meadows

Four types of meadows fall under this category. All four are fens in which the ground usually does not dry out for any part of the year. These include:

1) Douglas spirea-bog blueberry/sedge. This plant community is found at elevations between 2500 and 5000 feet. The water table is located above or just below the high organic soils. Plants associated with this community are:

Scientific Name	Common Name
Juncus ensifolius	Swordleaf rush
Salix sp.	Willows
Carex vesicaria	Blister sedge
C.sitchensis	Sitka sedge
C. luzulina	Woodrush sedge
C. muricata	Muricate sedge
C. obnupta	Slough sedge
Epilobium glandulosum	Common willowweed
Tofieldia glutinosa	Tofieldia

2) Sedge-twinflower-marsh marigold. (4000-5000 feet elevation) Deer and elk often forage in these areas. Plants associated with this community include:

Scientific Name	Common Name
Carex vesicaria	Blister sedge
C. lenticularis	Lenticulate sedge
C.luzulina	Woodrush sedge
Ceschampsia caespitosa	Tufted hairgrass
Dodecatheon Jeffreyi	Jeffrey shootingstar
Calamgrostis Canadensis	Bluejoint reedgrass
Hypericum anagalloides	Trailing St. Johnswort
Lysichitum americanum	American yellow skunkcabbage
Habenaria sp	Bog orchid
Boykinia major	Sierra boykinia

3) Sedge-panicled bulrush (2800-5200 feet). This plant community is often found adjacent to streams and is wet throughout the growing season. Soils in these areas have a high organic content. The following plants are associated with this community.

Scientific Name	Common Name
Carex sitchensis	Sitka sedge
C. Vesicaria	Blister sedge
Mimulus alsinoides	Chickweed Monkey flower
Calamogrostis canadensis	Bluejoint reedgrass
Hypericum anagalloides	Trailing St. Johnswort
Pedicularis groenlandica	Elephanthead pedicularis
caltha biflora	Twinflower marshmerigold
Cicuta douglasii	Western-water hemlock
Vaccinium uliginosum	Bog Blueberry
Salix sp.	Willows
Spiraea douglasii	Douglas spirea

4) Spirea-willow/sedge (2846-5200 feet elevation). This type of plant community is located on flat surfaces with a deep organic soil horizon. The water table is within 10 inches of the surface. Deer and elk visit this type of meadow often to forage and wallow.

Scientific Name	**Common Name**
Carex sitchensis	Sitka sedge
C. saxatilis	Russet sedge
C. luzulina	Woodrush sedge
Scirpus microcarpus	Panicled bulrush
Vaccinium uliginosum	Bog Blueberry
Juncus balticus	Baltic rush
J. ensifolius	Swordleaf rush
Salix sp.	Willow

5) Inflated sedge-Columbia sedge plant community is located around lakes and ponds along the crest of the Cascades. This type of meadow provides hiding cover for birds and small mammals. Plants include Blister sedge (*Carex vesicaria*) and Beaked sedge (*Carex rostrata*).

Moist Habitats

There are four types of moist meadows in the North Santiam subbasin. These types of meadows are wet into mid-summer. Associated wildlife includes mountain beaver, big game, Wilson's phalarope, common yellowthroats, Lincoln's sparrows and other songbirds. The four moist meadows are:

1) Blueberry-alpine spirea/grass found above 4000 feet elevation between the forest and water bodies. These moist meadows are found surrounding water bodies on the edge of forested landscapes. Deer and elk often browse in these areas. Plants include:

Associated Plant	Common Name
Vaccinium caespitosum	dwarf blueberry
Vaccinium occidentale	western bog blueberry
Vaccinium scoparium	Grouse huckleberry
Vaccinium deliciosum	Dwarf Blue Huckleberry
Deschampsia caespitosa	Dwarf blueberry
Calamagrostis canadensis	Bluejoint reedgrass
Antennaria microphylla	Rosy pusytoes
Lycopodium sitchense	
Aster alpigenus	Alpine aster
Agoseris aurantiaca	Orange agoseris

2) False hellebore-common cowparsnip plant community (3240-5600) has a water table deeper than 8 inches from the surface with a moderate to organic soil content. Deer and elk use these areas for foraging on the following plants:

Scientific Name	Common Name
Camassia leichtlinii	Lechtlin's camas
Senecio triangularis	Arrowleaf groundsel
Stachys cooleyae	Cooley's betony
Viola sp.	Violet
Mimulus guttatus	Common monkeyflower
Erigeron peregrinus	Peregrine fleabane
Geum macrophyllum	Largeleaf avens
Alnus sitchensis	Sitka alder
Rubus spectabilius	Salmonberry
Oplopanax Horridum	Devils club

3) Coneflower-bracken fern is a plant community with low plant diversity. Three plants are located within this meadow and include Coneflower (*Rudbeckia occidentalis*), Bracken fern (*Pteridium aquilinum*), and Leafy pea (*Lathyrus polyphyllus*).

4) Tufted hairgrass meadows are common at the higher elevations along the crest of the Cascades within the subbasin. These sites receive their moisture from summer snowmelt and remain moist throughout most of the growing season. Plants associated

with this meadow include Tufted hairgrass (*Deschampsia caespitosa*), Rush (*Juncus spp.*), and Alpine Aster (*Aster alpigenus*).

Dry Habitats

There are five types of dry meadow types located within the subbasin. Most of these habitats are found on south to southwest facing slopes where water is available only during spring runoff. Wildlife associated with this type of habitat includes kestrels, bluebirds, big game, bear, pocket gophers, voles, mountain quail, small mammal predators and great grey owls. These five dry meadow communities include:

1) Blue wildrye-brome is located on dry ridge tops between 2440 and 5800 feet. Plants associated with this meadow include:

Scientific Name	Common Name
Bromus inermis	Smooth Brome
Elymus glauca	Blue wildrye
B. tectorum	Cheatgrass brome
Achillea millefolium	Western Yarrow
Festuca occidentalis	Western fescue
F.rubra	Red fescue
Stipa occidentalis	Western needlegrass
Danthonia sp.	Danthonia
Lomatium triternatum	Nine-leaf lomatium

2) Common vetch-peregrine fleabane-blue wildrye is found on south-facing slopes between 2900 and 5660 feet elevation in well-drained soils. By late spring this type of meadow is dry.

Scientific Name	Common Name
Bromus inermis	Smooth brome
Amelanchier alnifolia	Serviceberry
rubus parviflorus	Thimbleberry
Holodiscus discolor	Oceanspray
Allium sp.	Onion
Aster sp.	Aster
Pteridium aquilinum	Bracken fern

3) Thimble berry/pookweed fleeceflower plant community is located at elevations between 4250 and 4800 feet in dry, exposed areas. Other plants found in this meadow include:

Scientific Name	Common Name
Rubus parviflorus	Thimbleberry
Polygonum phytolaccefol	Pokeweed fleeceflower
Calamagrostis sp.	Reedgrass
Artemisia ludoviciana	Louisiana sagebrush
Pteridium aquilinum	Bracken fern
Mertensia campanulata	Idahow bluebells

4) Wooly eriophyllum-varileaf phacelia (4840-5300 feet elevation) plant community is located on severe, south-facing slopes with deep snow packs. By mid-summer these meadow sites are dry. Plants associated with this community include:

Scientific Name	Common Name
Eriogonum compositum	Northern eriogonum
Sedum oregnense	Creamy stonecrop
Juniperus communis	Common juniper
Amelanchier alnifolis	Serviceberry
Holodiscus discolor	Oceanspray
Symphoriocarpos sp.	Snowberry
Agrostis diegoensis	Thin bentgrass

5) Beargrass-red fescue plant community is found in cold dry areas, usually mountaintops at elevations of 4700 to 5800 feet. The plants grow on pumice and parent rock and are thus subject to erosion.

Scientific Name	Common Name
Lilum columbianum	Columbia lily
Anemone lyalii	Nine leafed anemone
Carex pensylvanica	Long-stolen sedge
Pinus monticola	Western white pine
Amelanchier alnifolia	Serviceberry

Fauna

The Northern Cascades with its diverse vegetation supported and continues to support a large population of fauna. These fauna were of economic importance to prehistoric and historic Native American groups. Fauna that roamed the Cascades in historic times include elk, black tailed deer, mule deer, black bear, mountain lions, small furbearers such as snow hare, several varieties of squirrels, rabbits, red fox, coyotes, bobcat, martens, beaver, river otter, mink, weasel, and muskrat. Species now extinct in the area include Grizzly bear and the timber wolf. Birds include pileated woodpecker, ruffed grouse, blue grouse, harlequin ducks, western pond turtle and other waterfowl. Raptors include eagles, falcons and several species of hawks and owls. Both native cutthroat trout are common to smaller streams, and rainbow trout, white fish and sculpin are common to the larger streams. Anadromous fish including spring Chinook, Coho, and winter steelhead salmon spawned in the lower elevations along tributary streams below Willamette Falls, on the Willamette River near Oregon City. During years of high water runoff, salmon would be able to ascend the falls making their way up into the major tributaries including the North Santiam River.

Post-Glacial Climate and Vegetation

Fossil pollen records preserved in lake and bog sediments provide additional data on the post-glacial vegetation and climate in the Cascades. These data are important for understanding how mountain forests responded to postglacial environmental conditions over the past over the past 10,000 years (Sea and Whitlock 1994).

Early Holocene 10,000-5,000 B.P.: Warmer and drier than Present day.

Climatic conditions were generally warmer and dryer than present at all elevations and latitudes (Sea and Whitlock 1994). Plant species shifted their upper limits range by 825 to 1650 feet upslope and the distribution of xerophytic vegetation was more widespread in the region than at present (Sea and Whitlock 1994).

Research at Indian Prairie, located south of the North Santiam subbasin on the western edge of the Cascade Range (988 m elevation), suggests that a closed forest of *Pseudotsuga* and *Abies* was present from 10,000 to 4000 B.P. A combination of warmer conditions and frequent fires would have reduced the role of *Abies* compared to the preceding period. Pollen data from Indian Prairie indicate that *Quercus* and *Corylus* extended their range upslope by as much as 500 meters, which is further evidence of summer drought (Sea and Whitlock 1994).

Pollen from East Wolf Meadow suggests the occurrence of a closed forest of *Pinus* and *Pseudotsuga* from 6750 to ca. 4000 B.P. East Wolf Meadow is located south of the North Santiam subbasin in the Western Cascade Province at an elevation of 3300 ft. Pollen studies at Gold Lake Bog in the High Cascades provides evidence of wide spread higher elevation *Pinus* and *Abies* from 9500 to 4500 B.P (Sea and Whitlock 1994).

Late Holocene 5,000 to Present (Modern Day Climate)

This period marks the beginning of the present-day climate and the establishment of modern day vegetation types and fire regimes. During this period, cool humid conditions developed as summer radiation decreased and the east Pacific Subtropical High weakened (Barnarsky et al. 1987).

In the Western Cascade Province a closed forest of *T. heterophylla, pseudotsuga*, and *Abies* formed at about 4000 B.P. at Indian Prairie. In the High Cascades province, *T. mertensian, Picea engelmannii* and *A. lasiocarpa* dominated the vegetation around Gold Lake Bog after 4500 B.P. (Sea and Whitlock 1994). Over the past 2000 years at Gold Lake Bog, an expansion of *T.mertensiana* and *Abies* implies a development of mature forest and longer fire return intervals. Sea and Whitlock (1994) note that the appearance of modern forests varies in different areas as a result of differences in local climates, elevation, aspect, and fire regime.

Fire Regimes

Forest fire is considered to be a major element of the natural disturbance regime along the western slopes of the Cascades (Morrison and Swanson 1987). Most of the research on fire regimes along the western slopes of the Central Oregon Cascades has been conducted south of the North Santiam subbasin, in the McKenzie and South Santiam drainages (Morrison and Swanson 1987; Teensma 1987; Burke 1979). These studies conclude that both relatively infrequent catastrophic and more frequent under burnings were part of the natural, pre-fire suppression fire regimes. Mean fire return intervals varied considerably depending on the position of the landscape. Slopes with south aspects, or on ridges at higher elevations, or exposed to east winds, have the shortest mean fire return interval (Teensma 1987). Lower elevations in the valley bottoms and streamside have the lowest number of fires. Shorter fire intervals, from 78 to 127 years, have been documented around the period from 1750 to 1830 (Teensma

1987; Morrison and Swanson 1987). Morrison and Swanson (1987:57) documented an average of 15 years between fires during the A.D. 1796 to 1893 period, and 32 years between fires during A.D. 1515 to 1893 interval. Lightening is considered a major cause of ignition of fires in the western Oregon Cascades. Burke (1979) documented the equivalent of 12 lightning ignited fires per century per study area for the period of A.D. 1910 to 1977. Morrison and Swanson (1987) consider this number low, and argue that many undetected lightning ignitions most likely occurred.

Indian use of burning is best documented in the Willamette Valley, where the Kalapuya Indians intentionally burned grasslands each fall to facilitate the hunting of deer and the gathering of tarweed (Boyd 1986). Indian use of burning in the western Oregon Cascades is poorly documented, possibly because of the moist environment (Agee 1993). Winkler (1984) has documented Indian burning in the Middle Fork of the Willamette River subbasin. To meet their subsistence needs, Indians used fire to increase the game range, berry crops and probably a variety of other important plant foods such as bracken fern, elderberries and serviceberries.

In the North Santiam subbasin, the only evidence that Indians used fire was in discussion with some of the Warm Spring tribal elders, who mentioned that as children they would often light fire to the huckleberry grounds as they were leaving the area at the end of the picking season. This would enhance the huckleberry fields for future years. In the Upper North Santiam watershed, a significant amount of acreage burned between 1820 and 1850 along the North Santiam River, and on slopes west of the River (Leach 1995). Natural under burning appears to have been common along the North Santiam River bottom. Fires were also common at higher elevations in the southeastern part of the subbasin, where large stands of old growth tended to burn (Leach 1995). However, it is unknown whether these fires were human caused or lightning ignitions.

Summary

The western slopes of the Oregon Cascades are geologically ancient with more recent geologic events that have uniquely shaped the landscape. Over the last 10,000 years environmental conditions have remained relatively stable. Any changes in climatic conditions would have required adjustments in hunting and gathering strategies rather than dramatic social and economic change (Robbins 1997). Generally the topography of the North Santiam subbasin is highly diverse and vegetatively lush with gently sloping benches in one area, broad u-shaped valleys and rolling upland terrain in another, and large nearly vertical rock cliffs common elsewhere. Diverse vegetation communities were available to prehistoric groups, which most likely structured land-use and their seasonal procurement range in the North Santiam subbasin.

CHAPTER 3
ETHNOGRAPHIC AND ARCHAEOLOGICAL HISTORY

Introduction

This chapter presents background information on the lifeways of the ethnographically known Molala who inhabited the subbasin, cultural chronologies developed for the western slopes of the Oregon Cascades, hypotheses regarding the cultural affiliation of the Central Cascade archaeological sites, and a review of archaeological investigations in the North Santiam subbasin and surrounding area. This information helps support the interpretation of prehistoric land-use patterns for the North Santiam subbasin.

Ethnographic Overview

Archaeologists use ethnological data frequently as a basis for inference and as a test of the archaeological record in many parts of North America. However, ethnographic data for the Cascade Uplands, referred to as the traditional homeland of the Molala Indians, are virtually non-existent. What is known about their lifeways has been gleaned from historical accounts and early linguistic studies. Most of this information has survived in various government correspondence and linguistic field notebooks, usually in association with their neighbors, the Kalapuya (Toepel 1987). Part of the reasoning for this is the remoteness of the Cascade Mountains; ethnologists working in the area concentrated on the Willamette Valley, home of the Kalapuya Indians. Another factor is that the Molala suffered a dramatic population decline as a result of early white contact introducing disease.

The Molala are believed to have occupied much of the Western and High Cascades physiographic provinces of western Oregon from just south of Mount Hood south to the

Upper Umpqua river drainage (Figure 5: adapted from Zenk and Rigsby 1998). The Molala language is better known than their culture, primarily because linguistic accounts are the main source of information. Linguist Horation Hale, in 1846, was the first person to record linguistic information on the Molala (Toepel 1987). He suggested that the Molala language was closely related to Cayuse language of northeastern Oregon, and that they shared a recent common historical origin (Zenk and Rigsby 1998:439). Unfortunately, most of Hale's reference to the Molala language were based on missionary Marcus Whitman's memory of Cayuse Indian statements rather than solid linguistic evidence (Rigsby in Snyder1987:8). In the 1960s, Bruce Rigsby closely examined the evidence for a close Cayuse-Molala genetic relationship and found it lacking. He also concluded that there is no solid evidence for an early nineteenth century Molala migration into the Cascade. However, Zenk and Rigsby (1998:439) note "a number of share words may indicate contact, if not their proximity in an earlier period."

Based on the linguistic evidence, the Molala occupied the Oregon Cascades a few hundred to a few thousand years. Their language is classified as an isolate within the Penutian Phylum and is only distantly related to the Penutian languages spoken by most of the surrounding peoples (Toepel 1987). Ethnographer Leo Frachtenberg suggests two different dialects of Molala based on separate spoken dialects: the Northern Molala and the Southern Molala. The Northern Molala occupied the west slopes of the Cascades in the upper drainage of the Molalla River in the vicinity of Mt Hood. The Southern Molala occupied the upper Umpqua drainage and maintained close ties with Klamath to the east (Toepel 1987).

A third group which is poorly defined due to limited ethnographic and ethnohistorical data is known as the Upper Santiam or Santiam Band of the Molala. This band is acknowledged in the 1851 treaty proceedings but little else is known of them. Gibbs and Starling depicted the territory of the "Santiam Moolalle" on the 1851 treaty map (Figure 6: Gibbs and Starling 1851) as extending from Mount Jefferson in the southeast, north midway to Mount Hood, west to the headwaters of Silver Creek, and south to the headwaters of the North Fork of the Santiam River (Toepel 1987).

Figure 5: Molala Territory in Oregon.

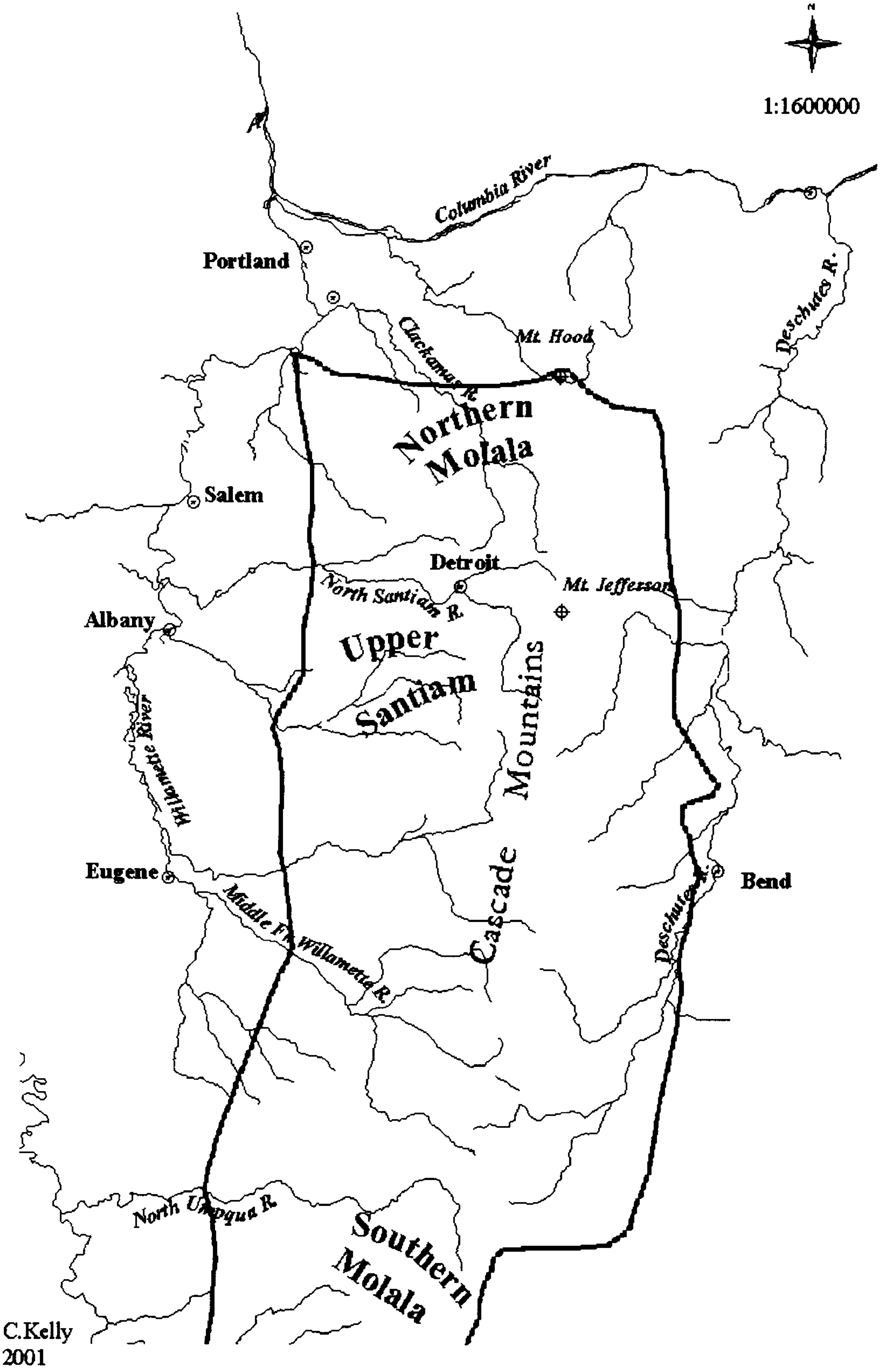


Figure 6: 1851 Map Displays the Reservation of the Santiam Band of the Moolalle Tribe.

Subsistence/Seasonal Round

Very little is known about the Molala as hunter and gatherers. Baxter (1986:16-18), suggests that the Molala may have followed a seasonal round similar to the Kalapuya-- an annual cycle of hunting and gathering. Early historical accounts point to the Molala as being hunters of wild game in the uplands of the Cascades during the summer and fall months.

Stern (cited in Toepel 1987:24) reported that the Klamath Indians frequently conducted fall hunts with the Southern Molala. The Molala also relied on berries (huckleberries, serviceberries, chokecherries, wild currants) and other plant foods that could be harvested during the summer and early fall from the uplands and traded along with smoked meat at Willamette Falls for salmon (Zenk 1976 cited in Toepel 1987).

Historical accounts reported in Toepel (1987:24-25) suggest that the Molala mainly used the bow and arrow to kill land animals, however snares, deadfalls, and pitfalls were also used as well as deer-head disguises for stalking. Bows were made from yew wood and arrow shafts from serviceberry (Spier 1930 c.f. Toepel 1987:28). The Molala also trained dogs to track or drive deer toward the hunter. Data recovery at the Diamond Lil Deer Kill site (35LA807) suggests that the Molala gathered pushed, and herded deer to a narrow ridge where they were driven through a narrow chute onto a flat kill area (Flenniken et al. 1990). Hunting during the winter months appears to have been the most productive time of the year to secure large stores of meat (Toepel 1987).

Johnson (1998) reports on the birth of the Molala, a Nation of good hunters:

> From a place near the summit of Mount Hood, Coyote scattered the heart of Grizzly Bear whom he had just willfully slain. To what would become Molalas Country he threw the heart and said, 'Now the Molala will be good hunters: they will be good men, thinking and studying about hunting deer.'

> Grizzly's demise, and hence the birth of the Molala Nation came about when he met Coyote who was on his way to 'make the world', according to an old Molala story. The Great Bear demanded a fight but Coyote cunningly challenged him to a red-hot rock swallowing contest instead. But Coyote cleverly swallowed strawberries while Grizzly gulped down hot stones that burst his heart. After much thought Coyote skinned and cut up Grizzly and while scattering his body to the winds he fore told that the Molalla's people 'will think all the time they are on the hunt'.

The lack of anadromous fish in the upper drainages suggests that fishing was of secondary importance. Cheatham points out (1988:199 cited in Aikens 1993:189):

> The lava flow that underlies the Willamette River near Oregon City stands in a special relationship to prehistoric cultural development in the Upper Willamette Valley, for the waterfall it created there presented an almost insurmountable barrier to anadromous fish attempting to migrate upstream. The result was that salmon constituted at best an undependable subsistence resource for the prehistoric peoples who lived upriver. The lava sill also prevented the river from increasing its slope, resulting in the maintenance of a broad, moist valley flood plain in the Upper Willamette Valley, an ideal setting for abundant propagation of the camas lily. In effect, the falls denied Willamette Valley natives the use of salmon, a major subsistence resource throughout the Northwest Coast and Plateau, while significantly increasing the availability of camas, a secondary staple elsewhere.

Rigsby (n.d: 2 cited in Toepel 1987:26) reported "that the Molalas wintered in sites located along streams in the lower elevations, usually west of the Cascades." Small family groups occupied their rectangular houses, which were probably semi-subterranean. The basic building material for the structures consisted of plank like slabs of hemlock and cedar bark, peeled at full thickness during the spring and then weighted down to dry flat (Zenk and Rigsby 1998:441). These materials were lashed vertically as walls and roof to a single log ridgepole, two upright forked center posts supported by a gabled framework of poles (Ibid). Based on the summer houses built by the Klamath, Kalapuya, and Tenino, the Molala probably constructed them from mats and/or brush. (Toepel 1987:27). Archaeological evidence to support this has not been documented.

Social Organization

Molala social organization consisted of one or more extended family households at sheltered low-elevations sites (Zenk and Rigsby 1998). These groups usually wintered together and often moved around as a single group (Toepel 1987: 28). Toepel reports that:

> The Molala followed a bilateral kinship system; the relatives of both parents were important in kinship reckoning. Kindred exogamy, marrying outside of one's immediate kin group, was the norm. The Molala frequently intermarried with other groups with whom they had friendly relations, including their Chinookan, Sahaptin, Klamath, and Kalapuyan neighbors (Ibid).

Social stratification was probably absent in the Molala organization. Leadership was obtained by personal reputation, family status and an individual's abilities. Religious practice and ceremonies are not documented; they did, however, cremate their dead, and the males probably undertook vision quests (Toepel 1987:30).

Baars (1981:13) quotes an informant who as a child in the early 1900's remembers seeing a Molala sweathouse:

> The houses were about 8 feet in diameter. They were circular, covered with cedar bark and skins with a small hole in the center of the top for smoke to escape. A hide covered the small doorway. Inside, the entire floor was covered with rock. In the center, inside a circle of upright rocks, you could see where a fire had been built. Around the wall was a circle of stone seats. There were about six seats with large flat stones forming the backs and seats with rocks placed between each seat to form arm rests.

Trade and Social Interaction with other Tribes

Many other Indian groups are known to have frequented the Cascade uplands to hunt, fish, gather plant foods, visit hot springs and procure obsidian and other stone tool material. The Tenino from east of the Cascades in the Deschutes drainage traveled into the uplands to hunt and gather plant foods (Toepel 1987). Henn (1975:457) quoted in Toepel 1987:22) describes the Warm Springs Reservation Indians traveling into the western Cascades to the Indian Ridge Site "apparently, the area was used in the autumn for collecting huckleberries and hunting deer."

The Klamath Indians, bordering the Southern Molala on the east, made frequent trips into the Cascades to hunt and gather plant foods. After historic contact, the Klamath traveled to Oregon City and the Dalles to trade. The Klamath may have served as middlemen for the Molala during trade at The Dalles and Oregon City. The Molalas sometimes traded buckskins to the Klamath for pond-lily seeds (*wokas*) and beads (Toepel 1987:28).

The Kalapuya occupied a major portion of the Willamette Valley. The Santiam band of the Kalapuya are known to have occupied the lower Santiam drainage and most likely interacted with the Upper Santiam or Santiam Molala. The Molala sometimes made raids on the upper Willamette Valley Kalapuya groups for slaves to trade at Oregon City or purchased from the Klamath Indians (Toepel 1987:23). This involvement in the slave trade may reflect the Molalas close ties to Klamath. Zenk and Rigsby (1998:443) note that the Klamath "played a major role in supplying slaves to the regional trading and holding centers on the lower Columbia and lower Willamette rivers." In turn, the Cayuse, the Nez Perces and the Northern Pauite attacked the Molala for slaves (Zenk and Rigsby 1998:443, Toepel 1987). The Northern Pauite "are most frequently posited to be responsible for the move of the Molala into the Cascades, and are "known to have raided the Molala, Klamath, and Tenino for slaves and horses (Toepel 1987:23)." Zenk and Rigsby (1998) note that the Molala did not obtain horses until the 1820s and 1830s from northeastern and central Oregon peoples. The acquisition of horses would have dramatically increased Indian mobility and thereby affected Indian economic and social life (Robbins 1997:46).

Travel Routes

An extensive network of mountain trails linked the Molala Indians to each other and to surrounding tribes. Today, known historic trail routes provide evidence for trans-Cascade movement by the Indians. Oral history related by the elder women of the Warm Springs Confederation suggests that the area was used by tribal members en route to the hot springs along the Breitenbush River and to their fishing grounds along the confluence of the North Santiam and Breitenbush rivers. They would cross over from the eastern side of the Cascades along the Lemati and old Rapidan trail and often camped near the springs during the summer. At the springs, the men dug out pools in the rocks for use as bathing areas, while the women apparently spent at least part of the season on the slopes of Mansfield Ridge (Northern subbasin boundary) (Griffin 1985: 101). The Warm Spring Indians would arrive at the confluence during the fall and net fish for White fish (personal communication, Warm Springs elders). My mother-in-law, Deanie Kelly, who grew up in the North Santiam Canyon, remembers in her youth watching the Warm Springs Indians fishing and drying their catch at the confluence of the North Santiam and Breitenbush Rivers. In discussions with the Warm Springs elders, they mentioned that this area was a large encampment that was very popular to gather not only to fish but also to gamble. Gambling was a major activity that brought the Klamath Indians to the area; sometimes wives or teams of horses would be gambled.

A trail in the vicinity of Mount Jefferson is referenced many times in oral histories, historic accounts (Vernon 1934), and by the Warm Spring elders. In discussions with the Warm Springs elders, they mention traveling by horseback with their grandparents and parents over the Cascade Mountains via Mount Jefferson along the Cabot Creek trail to gather huckleberries in Grizzly Flats, then down Lizard Ridge to Minto Mountain and east to the North Santiam River. Warm Springs also traveled to Marion Lake and Marion Basin for huckleberry picking along the well-known Minto Pass trail. Elmar Sundan (1937) describes the Warm Spring Indians crossing the Cascade Crest via Mt. Jefferson, then by way of Buck Mountain, Scar Mountain and continuing down into the Middle Santiam drainage. Scar Mountain was popular (and still is today) for its abundant huckleberry fields. The number of prehistoric sites located along the probable travel routes suggests that these routes have been principal east-west thoroughfares over a long period of time, long before the establishment of the Warm Springs reservation.

A principal south-north travel route is the Klamath trail which "begins in the territory of the Klamath Indians east of Crater Lake and continues north along the eastern side of the Cascades to the vicinity of Mount Jefferson (Minor and Pecor 1977:31)." At this point the Klamath Trail divides: "one branch continues northward, probably down the Deschutes River Valley to the Columbia River. The other branch turns west across the Cascades by way of the north fork of the Santiam River to the settlements of the Northern Molala on the Molala River; there it merges with the Molala Trail and terminates at Oregon City (Stern 1956:233-234 in Minor and Pecor 1977:31)." Stern (1998: 456) notes that with the advent of the horse and the fur trade in the early 1800s, the "Klamaths were traveling the Klamath Trail northward to the Kalapuya and Clackamas settlements about the Willamette Falls and to the Tygh band of Sahptins, whence they visited the trading center at The Dalles."

Dramatic population decline in the Molala and neighboring groups took place with the influx of white contact. The Bureau of American Ethnology estimates that the pre-contact population number for the Molala and Cayuse was 500 (Toepel 1987). Mackey (1974:125) reports that the unratified Champoeg treaty of 1851 listed 58 members (20 men, 30 women, and 8 children) of the "Santiam Moolalle" tribe present during the signing by Crooked Finger, Qui-eck-e-te, and Yal-kus. Sixty-five people were listed (20 men, 30 women, and 15 children) under the leadership of Coast-no Chief of the Santiam Band during the signing of the 1851 unratified treaty at Champoeg. Zenk and Rigsby (1998: 444) report that 121 Molalas survived, excluding Southern Molalas.

The ratified Dayton and Molala treaties of 1855 provided for the removal of all Molalas to the Grand Ronde Reservation, but many of the Southern Molala moved to the Klamath Reservation instead.

Cultural Chronologies

The Cultural-Historical Approach dominated archaeological research in the Pacific Northwest prior to the 1970's. This approach to the archaeological record stems from Franz Boas's Historical Particularism. Boas argued that anthropologists needed to emphasize culture by itself and look at each culture as a unique entity to be understood on its own terms (Trigger 1989). To do this, anthropologists needed to look at culture traits and their distribution. Boas coined the term Culture Area and argued that this is where shared traits are found. In Boas's view, change was a result of diffusion.

Boas's influence on archaeologists stemmed from the interplay between cultural anthropology and archaeology (Trigger 1989). Archaeologists could relate to Boas's Historical Particularism because their excavations recovered artifacts that enabled them to define cultures through time and space based on morphological similarities. This precipitated an era of descriptive archaeology throughout America until the 1950s, with an emphasis on artifact classification and chronology building. Archaeologists during this era were less interested in looking at change taking place within a culture. If change was addressed, it was attributed to diffusion. The cultural-historical approach is a necessary prerequisite for future theoretical approaches to interpreting the archaeological record. It is for this reason that chronologies are still being developed throughout the United States for different cultural areas.

In the Central Cascades researchers developing cultural chronologies for the Oregon Cascades have relied heavily on cross-dating of typeable projectile points (Minor and Toepel 1981 and Baxter 1986). This is due to the heavy precipitation in the Cascades, which creates an environment that is not conducive for preserving organic artifacts or features suitable for dating. Three widely recognized point types have been used to develop general chronologies (Table 1). These are foliate or leaf-shaped spear points broad-necked atlatl points and narrow-necked arrow points (Figures 55-65) (See Minor and Toepel 1981; and Baxter 1986).

Minor and Toepel (1981:161-176) proposed a detailed cultural chronology for the western Oregon Cascade foothills based on material data derived from previous excavation work at Cascadia Cave, Baby Rock Shelter, Rigdon's Horse Pasture Cave and other rock shelters. Baxter (1986) assessed and refined Minor and Toepel 's cultural chronology. He developed a local sequence based on work conducted at four sites in the Upper Middle Fork of the Willamette sub-basin.

Early Archaic Period (8000-6000 B.P.)

Minor and Toepel (1981 and Minor 1987) define this period as the Cascadia phase and Baxter (1986) has called it the Oakridge phase. These phases have been defined by the presence of large lanceolate or leaf shaped projectile points, often referred to as "Cascade" points (Butler 1961). The lower components at the Ripple site (Lebow 1984) and the Blitz site (Minor and Toepel 1984) and the entire occupation at the Geertz site (Woodward 1972) produced the leaf-shaped projectile points indicating initial occupation during the Cascadia phase. The early component of Baby Rockshelter (Olsen 1975), which lies below a Mazama ash layer (created by the eruption of Mount Mazama in 6800 B.P.), has also been assigned to the Cascadia phase (Minor and Toepel 1981; Minor 1987). A radiocarbon date of 7910 +/- 280 BP from Cascadia Cave has been used to establish the beginning of the Cascadia phase along with the Early Archaic period. A tentative date of 6,000 B.P. has been set for the end of the Early Archaic. Archaeological sites from this time period are thought to represent seasonally occupied camps of highly mobile hunter and gatherer groups.

Current research in the Cascades has found the Cascade point style to persist throughout the Middle Archaic period and into the Late Archaic period. Burtchard (1990:176) reports that dart points including foliate Cascade styles continued to be used contemporaneously with arrow points on Posy Ridge. South of Posy Ridge, in the North Santiam subbasin, Werner et al. (1998) excavated several sites associated with the Bruno Meadows Archaeological Complex. The dominant tool form throughout the archaeological assemblage is the foliate point. These sites were occupied well into the Middle and Late Archaic periods based on the recovery of two radiocarbon dates (3720±. 120 B.P. and 930±50 B.P.) Nilsson (1989) notes that leaf-shaped bifaces are commonly found at sites in central Oregon Cascades, the Willamette Valley, southwest Oregon, southern Columbia Plateau and northern California spanning a period ranging from 8000 B.P. to 1000 B.P.

Data Recovery of the Canyon Owl Site (Fagan 1992) indicates primary occupation of the site occurred in the Early and Middle Archaic periods with initial use beginning at ca 8,000 years B.P. Evidence for this time period is based on temporally diagnostic projectile point styles which include lanceolate, stemmed, broad necked notched points, and narrow-necked notched points. Fagan (1992: 62) notes "hydration band thicknesses for the obsidian projectile points indicate that the lanceolate [foliate] points were the earliest point types and that they persisted throughout the sequence."

The lack of associated radiocarbon dates makes these points generally poor chronological markers. Based on these findings, the Cascade style point as a temporal marker is inadequate and seriation profiles should be considered suspect unless rigorously established and tied to independent dating techniques (Burtchard 1990).

Middle Archaic Period (6000 B.P.-1800 B.P.)

Named after Baby Rock Shelter (Olsen 1975), Minor and Toepel (1981; Minor 1987) assign the Baby Rock phase to this period. Broad-necked projectile points recovered from the middle levels of this rockshelter are considered representative of this phase. These broad-necked stemmed projectile points (both expanding and contracting stems with neck widths greater than 7.5mm) are assumed to be used with the atlatl and dart weapon system and may be notched on the side, corners or bases. Minor and Toepel (1987) report that the broad necked projectile points have been recovered from almost every major site in the Cascade uplands, suggesting a widespread manifestation of this phase. They also point out that this phase is poorly dated with only two radiocarbon dates, 2565 +/- 85 BP from Packard Creek site (Heid 1987) and 2450 +/- 60 from Rigdon's Horse Pasture Cave (Baxter et al. 1983; Baxter 1986).

Baxter (1986) refers to this period as the Staley phase and extends its ending date to 1000 B.P. based on excavations at Horse Pasture Cave, Vine Rockshelter, and several lithic scatters which point to a later adoption of the bow and arrow in the Upper Middle Fork of the Willamette River. Archaeological sites of this time period appear to represent mobile hunter-gatherer groups adapted to the Cascades upland prairies and forest edge ecotones (Smith et al. in draft). The presence of mortars and pestles in lower elevation artifact assemblages is viewed as representing an increased emphasis on vegetal, nuts and seeds, which became staple resources in the Late Archaic (Minor 1987:45).

Late Archaic Period (1800 B.P.- A.D. 1750)

The Rigdon Phase, or Late Archaic period, is characterized by the presence of a variety of forms of small narrow-necked (7.5mm and less) points used with the bow and arrow weapon system. This phase is named after Rigdon's Horse Pasture Cave (Baxter et al. 1983; Baxter 1986). Radiocarbon dates of 590+/-80 years BP from Horse Pasture Cave, 398 +/-90, 530 +/- 70 BP from Vine Rockshelter (Baxter and Connolly 1985), 1560 +/- from Dead Horse Rockshelter (Swift 1986), and 1780 +/- 80 BP from the Packard Creek site (Heid 1987) fall within the estimated time span of the Rigdon Phase.

Baxter defines this period as the Colt Phase (1000 B.P. to A.D. 1800). According to

Baxter, the ethnographic Molala moved into the Upper Middle Fork of the Willamette sub-basin area, replacing the Staley phase people. The primary difference between Baxter's and Minor and Toepel's chronology is the endurance of the broad-necked, stemmed and notched projectile points until circa 1000 BP. The various phases are based on the characteristics of distinct projectile point styles and ten radiocarbon dates (Baxter 1986). Baxter also notes that the McKenzie River appears to be the northern extent of Colt Phase material.

The discrepancy between Minor and Toepel's (1981) and Baxter's (1986) beginning date of the Late Archaic Rigdon phase, and that of Baxter's Colt phase, is largely attributed to the fact that the Ridgon phase (Minor and Toepel) starts when small narrow-necked points first appear in the archaeological record, while the Colt phase (Baxter) is defined by the predominance of these points (Nilsson 1989).

Historic Period (A.D.1750. - Present)

During the Ethnographic phase or Historic period a rapid decline took place in the native population. Along with the decline in population came an acculturation of the native peoples to Euro-American material culture and lifeways, with the eventual abandonment of their traditional aboriginal cultures (Minor and Toepel 1981). This phase encompasses archaeological manifestations dating from the time of historic contact to the final removal of the Indians to reservations in A.D. 1855 when the Dayton Treaty was signed between the U.S. government and the Kalapuya and Molala peoples.

Cultural Affiliation

Several hypotheses of the cultural affiliation of the archaeological sites found in the Central Cascades have been proposed. One argument advanced by Newman (1966), Henn (1975), and Olsen (1975) is that western Cascade sites represent summer high altitude manifestations of Columbia Plateau and/or Great Basin Cultures. This interpretation is based on the similarity of Cascade style points used in the Columbia Plateau and points recovered from Cascadia cave. Researchers (Davis, 1973:36-37; White 1975:36-37, 53) working in the Willamette Valley propose that archaeological sites in the Oregon Cascades may represent seasonal upland manifestations of prehistoric Willamette Valley Cultures.

Table 1: Comparative Cultural Chronologies for the Central Oregon Cascades.

YEARS BEFORE PRESENT	PERIOD REFERENCE AFTER MINOR 1987	MINOR 1987 PHASES	BAXTER 1986 PHASES	CLIMATE
Present	Historic	Ethnographic Molala	Horse Pasture	
500 B.P.				
1000 B.P.	Late Archaic		Colt Phase	
1500 B.P.		Rigdon Phase		Modern Day Climate
2000 B.P.				
2500 B.P.				
3000 B.P.				
3500 B.P.				
4000 B.P.				
4500 B.P.				
5000 B.P.				
5500 B.P.				
6000 B.P.	Middle Archaic	Baby Rock	Staley	Warmer And Dryer
6500 B.P.				
7000 B.P.				
7500 B.P.				
8000 B.P.	Early Archaic	Cascadia	Oakridge	
8500 B.P.				
9000 B.P.				
9500 B.P.				
10,000 B.P.				
11,500 B.P.	Paleo-Indian	??	??	
13,500 B.P.				

Another interpretation is that the sites reflect high altitude manifestations of both Columbia Plateau/Great Basin and Willamette cultures seasonally inhabiting the eastern and western flanks or interior mountain valleys. Cole (1968 from Minor et al. 1987) argued for a long-standing local cultural tradition in the Cascades based on the artifact assemblage recovered from Site 35LA33 which compares closely to the artifact types in the upper levels of Cascadia Cave.

Minor (1987:58-60) proposes that cultural affiliations of prehistoric inhabitants in the Cascades changed over time and are represented by at least two successive patterns of use:

> An early pattern represented by lanceolate and leaf-shaped projectile points and related to early manifestations elsewhere in the Pacific Northwest; and a later pattern represented by small narrow-necked projectile points and related to the ethnographic Molala occupation of the Cascades.

Minor correlates this later pattern of occupation with the hypothesis, that archaeological complexes along the western slopes of the Oregon Cascades were indigenous and not strongly related to cultures on either side of the Cascades.

Baxter (1986: 186-187) suggests that the "Molala movement into the Cascades corresponds to the sudden and overwhelming appearance in A.D.1400 of a distinct projectile point style that coincides with the Colt Phase in the Upper Middle Fork area (mainly desert side-notched)." He argues that this point style is distinctive to the Upper Middle Fork and the Umpqua Basin to the south but is not well represented in the northern McKenzie and Santiam drainages.

Based on evidence recovered from sites on the Willamette Valley floor, Minor (1987) suggests that the Molala occupied the Cascades throughout the Late Archaic period for at least the last 2000 years. By the Late Archaic period, " indigenous cultures had diverged from a common background to the extent that differences are apparent between archaeological assemblages from sites in the Middle and Upper Willamette

Valley (Minor 1987:59)." These differences appear to be equivalent to the territories occupied by the two main linguistic divisions of the ethnographic Kalapuya in the Middle and Upper Willamette Valley (Minor 1987: 60). Given this scenario, the Molala occupation of the Cascades is viewed as connected to the Late Archaic "settling in" of the ethnographic Molala and their ancestors who separated from surrounding native groups.

Baxter (1986) postulates that archaeological sites on the western flanks of the Oregon Cascades may represent indigenous upland cultural adaptations distinctive from the Columbia Plateau, Great Basin and Willamette Valley. Based on an ethnographic model of the Molala, he argues that upland lifeways were established in the region in antiquity and focused on seasonal availability of resources and ties to lower elevation village and campsites.

Previous Archaeological Investigations in the Western Oregon Cascades

Archaeological research in the upland Cascades began at Cascadia Cave (Newman 1966), Indian Ridge (Henn 1975), Fall Creek Dam Reservoir (Cole 1968) and Baby Rockshelter (Olsen 1975). A major focus of these investigations was determining cultural chronology and cultural affiliation. Today, research along the western slopes of the Oregon Cascades focuses on cultural chronology, cultural affiliations, and subsistence-settlement systems. The west slopes of the Central Cascade area lies at the interface of several major cultural areas: the Great Basin, the Columbia Plateau, and the Willamette Valley, and may have been occupied by a diverse group of cultures. Site assemblages consist primarily of flaked stone tools, expedient flake tools, and debitage resultant of tool manufacture and maintenance, and occasionally ground stone. Dating sites and placing them within a chronological framework has been difficult since wood, fiber, bone, vegetal fibers and charcoal are rarely found at sites in the Central Cascades.

Below is a summary of the results of test excavation and data recovery projects undertaken over the past 35 years in the Clackamas, North and Middle Santiam River drainages. The data sample has been recovered from generally small-scale excavations conducted to determine National Register of Historic Places significance; and to mitigate ground disturbing project impacts (Table 2). These field projects, coupled with the above ethnographic accounts, provide evidence of human occupation in the Cascades for at least the last 8,000 years and possibly as early as 10,000 years ago. With the exception of Cascadia Cave, which is distinctive in location and setting, the sites are summarized by landform (Ridgeline, River Terrace, and Meadow associated sites) and then by time period.

Cascadia Cave (35LIN11)

This site lies on the South Santiam River at an elevation of 900 feet amsl. This rockshelter is one of the earliest excavated sites in the western Oregon Cascade uplands. Excavations at the cave yielded the earliest known radiocarbon date in the Central Cascades of 7910± 280 years B.P. in the lower 90 cm of the cultural deposit (Newman 1966). Approximately 400 artifacts were recovered from Cascadia Cave including the leaf-shaped "Cascade Point", side and corner notched points, side scrapers, drills, handstones, millingstones, and large ovate knives and modified flakes. Newman notes that the majority of scrapers came from the upper levels, leading him to suggest an economic shift over time at the cave. Based on this increase in scrapers and an increase in faunal remains, Newman postulates an increased reliance on game from a more generalized exploitation of flora and fauna. He suggests that the faunal assemblage and the presence of hazelnut shells recovered from the cave probably represented seasonal use during the spring and summer. Newman proposed a 3,000 B.P. date for final abandonment of the cave but acknowledged that this termination date for human use could be later since looters removed the upper two meters of deposit.

River Terrace Sites

Human occupation of sites located along the lower elevation river terraces appears to span the Archaic (Table 2). During the Middle Archaic period, the data show that many of these sites were used intensively as temporary base camps on a repeated basis where hunting, and hide, meat, and plant processing were conducted (mainly along the Clackamas River). The artifact assemblages indicate that the reduction of obsidian and CCS quarry blanks and the maintenance and rejuvenation of projectile points and other hunting tools took place. To date there is no evidence to indicate that these low elevation sites served as winter settlements. There is less evidence of hunter-gatherer groups occupying these sites during the Early and Late Archaic.

Meadow Sites

The available data suggest that hunter-gatherer groups occupied meadow-associated sites during the Middle and Late Archaic periods (Table 2) on a repeated basis during their seasonal round. These meadow sites (Table 2) are located between 1128 (3700 ft) and 1220 m (4000 ft). A variety of east side obsidians, mainly in the form of projectile points, were collected from site 35LIN105, which is located along an ethnographically documented travel route, indicating that the site occupants had contact with groups east of the Cascades. The artifact assemblages suggest that the manufacture and maintenance of lithic tools took place at these sites.

Ridgeline Sites

During the Middle Archaic, hunter-gatherer groups used many of the small-dispersed lithic scatter sites along the ridgelines intermittently or as temporary stopover points, en route to important resource procurement areas that groups occupied as a field or temporary base camp on a repeated basis. Many of these intensively used sites are located in broad ridgeline saddles between 1036 (3400 ft) and 1402 m (4600 ft) in elevation. The artifact assemblages from these sites indicate that a variety of tool production activities took place, including early through late-stage biface tool production, and the repair and maintenance of projectile points, suggesting a focus on hunting. The recovery of a hopper-mortar from site 35LIN515 provides evidence of plant processing (Draper et. al 1994). These upland sites are all located along major travel routes that may have served as trade networks connecting various geographic locations and resource procurement areas. Several of the upland sites indicate use during the Late Archaic period.

Conclusion

The available evidence suggests that groups were using the Cascades from at least 8,000 B.P. until the early 1900s. Our knowledge about the groups that occupied the area during the Archaic periods is based on ethnographic evidence, oral histories, and limited excavation work. The ethnographic evidence suggests that highly mobile groups indigenous to the western Cascade Mountains lived during the winter along low elevation streams, accessing the uplands during the summer and fall to hunt game such as deer and gather berries and other important plant resources. Extensive trail networks were important for traversing the Cascade Mountains, linking the Molala Indians with each other, surrounding tribes, and important resource procurement and trade centers. There is less evidence of site occupation during the Early Archaic than during the Middle or Late Archaic periods. During the Middle and Late Archaic, the data show that a variety of localities (Ridgeline, Meadows, and River terraces sites) were used intensively and on a repeated basis. The common activity at many of these sites is the manufacture and maintenance of lithic tools and biface reduction. The river terrace sites provide more evidence a plant processing, but do not indicate that they were occupied during the winter months.

Table 2: Excavated Sites in the North and Middle Santiam and Clackamas River Drainages.

Site Number	Elevation	Early Archaic	Middle Archaic	Late Archaic	Dating Method
35LIN11 (Newman 1966)	900 ft	X	X		Radiocarbon
Ridgeline					
35MA48 (Jenkins and Churchill 1988)	4000 ft		X		Projectile Points
35MA68 (Jenkins 1988)	3440 ft	X	X		Projectile Points
35MA22 (Churchill and Jenkins 1991)	4200 ft		X	X	Projectile Points
35LIN302 (Spencer 1989)	4050 ft		X		Projectile Points
35LIN301 (Nilsson 1989)	4320 ft		X	X	Projectile Points
35LIN515 (Draper et al. 1994)	4100 ft		X		RadioCarbon/ Projectile points
35LIN241 (Bell 1982)	4500 ft		X	X	Projectile Points
35LIN525 (Draper et al. 1994)	3700 ft		X		Projectile Points
35LIN374 (Beardsley 1988)	2760 ft		X		Projectile Points
35LIN252 (Lindberg-Muir 1982)	3689 ft		X	X	Projectile Points
35LIN373 (Flenniken et al. 1990)	3400 ft		X		Projectile Points
35CL21 (Burtchard 1990)	4500 ft		X	X	Projectile Points
35CL22 (Burtchard 1990)	4500 ft		X	X	Radiocarbon

Table 2: Continued.

Meadow					
35LIN104 (Werner et al. 1998)	3959 ft		X	X	Projectile Points
35LIN105 (Werner et al. 1998)	4000 ft		X	X	Projectile Points
35LIN107 (Werner et al. 1998)	4000 ft			X	Radiocarbon/ Projectile points
35LIN321 (Werner et al. 1998)	4400 ft			X	Radiocarbon/ Projectile points
35LIN253 (Jenkins and Churchill 1987)	3900 ft		No Date		
35LIN186 (Jenkins and Churchill 1987)	3700 ft		X		Projectile Points
River					
35LIN260 (Raymond 1985)	1760 ft		No Date		
35MA49 (Beardsley 1990)	1600 ft		X	X	Projectile Points
35LIN336 (Fagan et al. 1992)	1650 ft	X	X		Projectile Points/ hydration
35CL55 (Lebow 1984)	1500 ft	X	X		Projectile Points
35CL61 (Winthrop and Gray 1984)	2400 ft		X		Projectile Points
35CL42 (Woodward 1972)	560 ft		X	X	Projectile Points

Minor and Toepel (1981; and Minor 1987) and Baxter (1986) developed chronologies of the Central Cascades based on projectile point styles, changes in hunting technology and limited radiocarbon dating. One of the questions put forward is why and when did the bow and arrow hunting technology replace the earlier atlatl and dart or spear-thrower technology? Baxter suggests that the bow and arrow made its appearance around 1000 B.P. in the Upper Middle Fork Willamette area, which is possibly part of a larger pattern extending into southwestern Oregon (Baxter 1986:43). Minor and Toepel

(1987) argue that in the Columbia River, Great Basin, and Willamette Valley regions, the bow and arrow replaced the broad necked atlatl points around 2000 years ago. The following chapter provides current technological studies in the North Santiam subbasin that provides some evidence of this transition and contributes to the current Central Oregon Cascade cultural chronologies.

Excavation of sites and the recovery of datable material also allow researchers to address site function and cultural change throughout the human occupation in the Cascades. Unfortunately, in the North Santiam subbasin and the Central Cascades in general we still do not have a clear picture of culture change due to the limited excavation work and consequent lack of radiocarbon dates at sites. Because of this, researchers have focused on trying to understand land-use patterns and predict locations based on our knowledge of surface finds. Chapter Five presents a discussion of three land-use models proposed for the Central Oregon Cascades. These models provide a basis for addressing land-use patterns in the North Santiam Subbasin.

CHAPTER 4
TECHNOLOGICAL STUDIES

Introduction

Researchers in the Central Cascades are beginning to pay more attention to how obsidian hydration and X-ray fluorescence can contribute to our knowledge of the region (Lindberg-Muir 1988; Skinner and Winkler 1994; Bergland et al. 1994, Skinner 1986, 1997, Minor 1987). These two analyses have become increasingly important because lithic scatters dominated by obsidian are the most common site type found in the western Cascades. Data gathered from obsidian hydration are directed toward developing obsidian hydration as a method of relative and estimated absolute dating. The outcome results in a chronological ordering of lithic sites in which datable material is lacking. X-ray fluorescence analysis is a method for determining the parent geological source of obsidian artifacts. This information provides the basis for making inferences about patterns of human behavior such as mobility, trade and interactions, by studying the spatial distribution of obsidian from different sources. Over the past 15 years the artifacts recovered from sites in the western Cascades have been routinely submitted for trace element analysis by X-ray fluorescence spectrometry and obsidian hydration rim measurements.

X-Ray Fluorescence Analysis

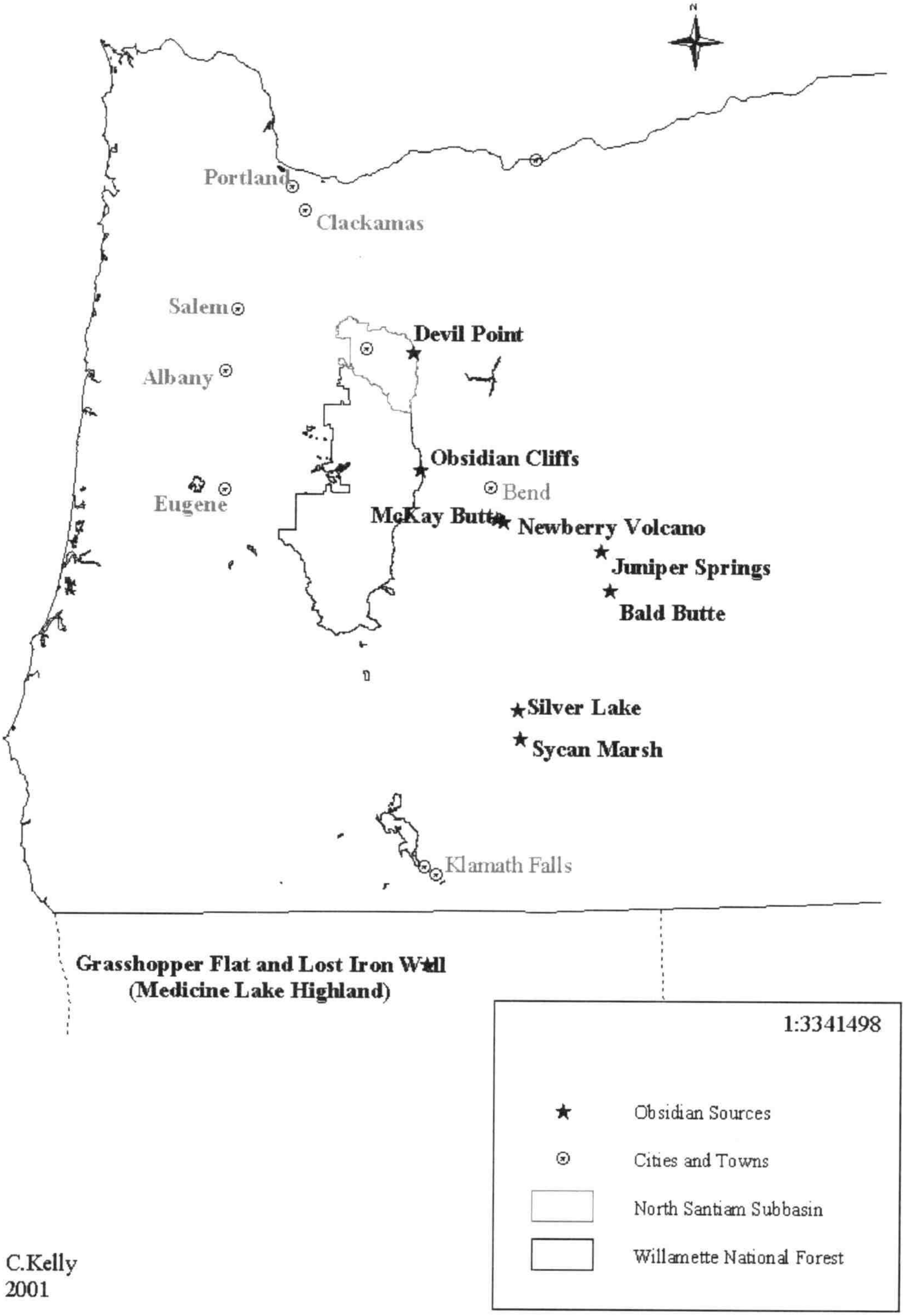
Energy dispersive x-ray fluorescence spectrometry is a non-destructive technique used for identifying the trace and rare earth elements of specific obsidian artifacts and correlating them with geologic sources (Hughes 1986). Information on the parent sources of raw materials used in tool manufacturing provides the basis for inference about the nature of prehistoric travel, trade networks and seasonal procurement ranges, cultural preference for a particular type of obsidian and the existence of intergroup interaction (Skinner 1997, Hughes 1986; Andrefsky 1994). These cultural variables influence the geographic patterning of characterized obsidian artifacts (Skinner 1997). Skinner (1997:13) points out that environmental variables can also influence the spatial patterning of obsidian artifacts. These include "the geographic distribution of quarry sources, the distance to source, the location of alternative or competing sources of lithic materials, raw material quality and abundance, tool stone size, the distribution of raw materials in secondary deposits, or the presence of potential barriers such as mountain ranges."

Many parent obsidian sources have been identified in Oregon and Northern California. Nine of the sources are of special interest to this study area. These include: Devil Point, Obsidian Cliffs, Carver Flow (western Cascade Mountain sources), Newberry Volcano, Juniper Springs, McKay Butte, Bald Butte, Silver Lake/Sycan Marsh (eastern Oregon) and GF/LW Med. Lake Highland (Northern California) (Figure 8). All of these parent materials to varying degrees appear in the artifact assemblages from the North Santiam subbasin. The two sources that dominate lithic scatter sites in the subbasin are Devil Point and Obsidian Cliffs. These sources are briefly discussed below along with the locations of the other obsidian sources that appear in the subbasin.

Devil Point Source

Devil Point Obsidian quarry is located at an elevation of 5100 feet northwest of Mt. Jefferson on the eastern end of a prominent east-west ridge within the North Santiam subbasin. Skinner (1997) describes the primary source area as surface float obsidian nodules originating from a relatively thin zone (10-20 m thick) in association with an outcrop of rhyolites exposed near the eastern end of the ridge. The presence of small phenocrysts and the occurrence of small spherulites make Devil Point source reliably visually distinguishable from other prehistorically used geologic sources.

Figure 7: Obsidian Source Locations.



C.Kelly
2001

Obsidian nodules are also found in the gravels of Grizzly Creek seven km south of Devil Point. Trace element analysis of the glass indicates that they belong to the Devil Point geochemical obsidian source group (Hughes 1989; Skinner 1997).
Obsidian of usable size for producing tools was found only within Grizzly creek and in the immediate vicinity of the Devil Point source.

Skinner (1997) suggests that the Devil Point source was primarily exploited for a relatively restricted time interval ranging from the Middle Archaic to the early historic. There is an increase in the intensity of Devil Point source use during the Middle Archaic and continuing into the Late Archaic. It is possible that this shift is due to an increase in trans-Cascade movement and the establishment of new routes across the Cascades, expanding population densities in the areas bordering the source, or a shift to the exploitation of higher elevations resources in the vicinity of the source (Skinner 1997).

Skinner (1997: 24) postulates that "The mediocre quality of the [Devil Point] glass, its rare occurrence in formed tools such as projectile points, the geographic proximity of other high-quality obsidian source, and the limited geographic distribution of Devil Point artifacts in relation to the source all argue for a raw material that was typically acquired directly as part of procurement behaviors embedded in the normal subsistence schedule."

Obsidian Cliffs Source

This source is located in the Central Oregon Cascades at the western base of the North Sister, Three Sisters Wilderness Area, in Lane County. Obsidian Cliffs refers to the 330 to 300-foot cliffs at the termination of a 1.5-mile long obsidian-rhyolite flow (Skinner 1983:98). The glaciated flow is a broad plateau, ranging in elevation between 6000 and 6600 feet.

The top of the Obsidian Cliffs flow, a plateau sloping upwards towards the Middle Sister, is covered in many areas by obsidian nodules with diameters commonly exceeding

20 cm. A layer of volcanic tephra blankets the entire area (Skinner 1986:11). It is the major obsidian source in the Cascade Mountains.

Skinner (1986:11) describes the Obsidian Cliffs source as a "pale gray rhyolite intermixed with glassy, gray-black and occasionally red obsidian. Spherulites and lithophysal bands are common...[and]...most frequently encountered...near the borders and the vent area of the flow." "Glacially-transported obsidian ended up in the McKenzie River which was further transported into the Willamette Valley, creating a secondary obsidian source consisting of gravels from both the McKenzie and Willamette Rivers (Skinner 1986:102)."

Obsidian Cliffs is an important lithic source both locally and regionally. Current research (South 1999) on lithic resource procurement at Obsidian Cliffs quarry indicates that primary reduction and biface blank production were the principal activities. Obsidian Cliff's material has been recovered at sites as far away as British Columbia.

The Central Oregon Cascade sites have a much higher percent of Obsidian Cliffs material than any other material, except for those sites in the North Santiam subbasin that are closest to Devil Point quarry (Skinner and Winkler 1991, 1994; Skinner 1997).

Newberry Volcano Source

This source is located south of the Three Sisters' Mountains, east of the Cascade Range, on the western end of the High Lava Plains Physiographic Province (Connolly 1999). Newberry Volcano obsidian sources became available around 6,400 years ago after the eruption of Mount Mazama, which dates to about 7,000 B.P. (Hughes and Connolly 1999: 166). Four obsidian flows constitute the Newberry Volcano obsidian sources but trace element profiles determined that there is no significant differences among the flows and they are thus consider of a single chemical type (Skinner and Connolly (1999: 155).

McKay Butte Source

McKay Butte obsidian is located about 7 km from the west rim of Newberry Caldera at the central dome of McKay Butte (Hughes and Connolly 1999:170). Obsidian studies indicate that McKay Butte glass was used extensively prior to the eruption of Newberry Caldera obsidian flows and that most of its use was confined primarily to pre-Mazama times (Skinner in Hughes and Connolly 1999). The reason for this pattern of use is that "most, or a large portion, of the McKay Butte source was covered by Mazama ash after ca. 7,000 radiocarbon years ago [so] that the occurrence of this glass in post-Mazama assemblages is largely a by-product of scavenging and recycling of older tools (Hughes and Skinner 1994:9 quoted in Hughes and Connolly 1999:173)."

Other sources include Silver Lake/Sycan Marsh located at several scattered outcrops near the town of Silver Lake and south of Silver Lake in the northeast margin of the Klamath Basin (Thatcher 2001); Juniper Springs Variety One located east of the Cascades; and Grasshopper Flat and Lost Iron Well obsidian sources located in Siskiyou County, California south of Medicine Lake (Hughes 1986).

Obsidian Hydration Analysis

Friedman and Smith first introduced the obsidian hydration dating method in 1960 (Friedman et al. 1994). Obsidian hydration dating is derived from the measurement of chemical and physical changes in thin surface layers of volcanic glass objects that result from the absorption of water. When a fresh surface is exposed during stone tool manufacture, it weathers by gradual adsorption of water. Water is slowly adsorbed from the surface into the interior of the artifact, causing changes in both the density and volume of those layers. The water comes from either the atmosphere or the soil where the obsidian artifact was deposited. The hydrated layer or rind becomes recognizable microscopically as a birefringent rim when it reaches a thickness of about 0.5 microns (Skinner et al. 1997). This rind is analyzed by cutting thin sections from formed obsidian artifacts and debitage and measuring their thickness under polarized light at high magnification. Several measurements are taken along the edge of each thin section and the mean calculated. The thickness of the rims read in microns is seen as a function of time. Freidman et al. (1997) note that a measurable hydration layer is formed within a few hundred years.

Numerous studies have addressed variables that can affect the formation of the hydration rim (Freidman et al. 1960; Mazer et al. 1991; Friedman et al. 1994; Friedman et al. 1997; and Stevenson et al. 1993, 1998). Friedman et al. (1997) explain that in order to derive an absolute age for obsidian artifacts, the temperature and the relative humidity at the archaeological site and the chemical composition of the obsidian is crucial. There are many problems with using obsidian hydration as an absolute dating technique including the difficulty of evaluating the influence of temperature variation on obsidian artifacts (Jones and Beck 1990). The other difficulty in constructing valid hydration rates is finding "bona fide" associations between obsidian artifacts and carbonaceous material (Friedman et. al.1997: 317).

Skinner et al. (1997:5) caution researchers who attempt to convert rind measurements to absolute dates, particularly when rates are borrowed from existing literature sources. They note, " When considered through long periods, the variables affecting the development of hydration rims are complex, and there is no assurance that artifacts recovered from similar provenances or locales have shared thermal and cultural histories (Skinner et. al. 1997:5).

Skinner (1997b: 6-13) summarizes several major investigations that address the effects of fire on obsidian hydration rim measurements. Most of the studies used a control sample and found that at about 400° C. the hydration band is no longer measurable. A light fuel fire or temperatures reaching around 100° C or less had no appreciable effects on the hydration rim of artifacts. Skinner (1997b:10) further notes that not only can exposure to human and natural caused fires erase the hydration rim is also capable of altering and increasing the hydration rim width at certain temperature ranges.

Researchers have conducted studies to compare hydration readings of buried artifacts and those found near or at the surface. Friedman et al. (1994) document several studies conducted using surface artifacts and found that there was little to no difference in rim thickness detected in the percent of surface versus buried artifacts. They note that the lack of temperature effects on the hydration rate may be a result of lower relative humidity on the surface artifacts countering the effect of solar heating (1994:188).

Michaels (1965, 1969: in Jones and Beck 1990) found no significant differences between the hydration readings of deeply buried artifacts and those found at the surface. Subsequent studies on the use of surface artifacts (Origer and Wickstrom 1982; Jackson 1984, Jones and Beck 1990 and Basgall 1995) have confirmed that the relative orders of hydration rim readings were consistent with the oldest style having the thickest rinds (Jones and Beck 1990:85).

Despite the problems associated with obsidian hydration analysis, researchers have demonstrated that it can be used in conjunction with obsidian sourcing to examine the history of source use and particular artifact types as relative chronological markers. To calculate relative (versus absolute) ages based on hydration rim measurements, only the chemical composition of the artifacts is necessary (Freidman et al. 1997: 299). The following section presents the results of obsidian sourcing and hydration analysis on projectile points collected within the North Santiam subbasin.

Current Research

One hundred-sixteen projectile points recovered from the surface and subsurface of the North Santiam subbasin were submitted for XRF-sourcing and obsidian hydration analysis over the past 20 years (Hughes 1986b, 1988, 1988b, 1988c, 1989, 1991, 1993, 1993b, 1994, 1999, 2000; Jackson and Allred 1994; Jackson et al. 1994; Origer 1988, 1988b, 1991, 1993, 1999, 2000; Origer et al. 1994; Skinner 1997, 1997b). Projectile points were chosen because they can be temporally sensitive artifacts. Four projectile point types (Western Stemmed, foliate, dart, and arrow) were selected to examine evidence for prehistoric use of raw material sources (local and non-local) for the production of tools and the seasonal procurement ranges of groups (Skinner 1997). Concurrent obsidian hydration analyses of the points was conducted to provide relative chronological data that may contribute to the cultural chronologies for the Central Oregon Cascades and for addressing the changes in raw material procurement through time.

Western Stemmed Points

The Western Stemmed artifacts are similar to the Windust points of the Columbia Plateau (Leonhardy and Rice 1970). Leonhardy and Rice (1970:4) described the Windust Phase projectile points to include "forms with relatively short blades, shoulders of varying prominence, principally straight or contracting stems, and straight or slightly concave bases."

This straight stem eared point rarely occurs in upland central Oregon Cascade sites. Connolly (1994:83) notes that the Western Stemmed projectile points have a long range of occurrence "with associated radiocarbon dates ranging from prior to 11,000 years ago to about 7000 years ago."

Numerous Western Stemmed points were recovered from the upper and lower pre-Mazama layers at Paulina Lake Site 35DS34 (Connolly 1999:164-170). Connolly (1999) divides these points into Stemmed Variety 1, 2 and 3 based on stem morphology, size, basal grinding and small ears protruding laterally from the base of the stem. Pre-Mazama occupation at the site extends from about 11,000 B.P. to 7,600 B.P confirming the time depth at the site (Connolly 1999:221).

Twenty-six Stemmed points have been recovered from 17 localities in the North Santiam subbasin (Table 6; Figures 49 and 50). Many of these points are similar to points recovered from the Paulina Lake Site. Fifteen (58 %) of the points from the subbasin were fashioned from obsidian, six (23 %) from basalt, and five (19 %) from CCS. Fourteen of the obsidian points were submitted for XRF and hydration analysis (Table 6). The artifacts fashioned from Obsidian Cliffs source material show a strong pattern of large hydration rim measurements, indicating that these sites were occupied during the Early Archaic and possibly earlier. Other sources include McKay Butte, Newberry Volcano, Devil Point and Carver flow.

Foliate Points

Willow or laurel leaf shaped type points (Crabtree 1972:66), or Cascade points generally have an ovate morphology where the blade expands from the tip to the midpoint, and then contracts from the midpoint to the base. Newman (1966:14) notes two other types of Cascade points, one in which "the tips are not necessarily sharply pointed, and the bases are usually distinctly rounded, conforming generally to the form of "willow leaf" and the other he describes as being "distinguished mainly by its lack of an even outline, and is characterized by insets and irregularities, many of which are apparently deliberate."

Foliate points have been recorded at 47 different localities in the North Santiam subbasin. Sixty-three (84 %) of 75 foliate points from the subbasin were fashioned from obsidian, three (4 %) from basalt, and nine (12 %) from CCS (Table 7; Figures 51-55). Forty of the obsidian foliate points were submitted for XRF and hydration analysis. The hydration rim measurements for Obsidian Cliffs material range from 0.9 to 4.3 μm, overlapping the hydration rates for the Western Stemmed, the dart, and the arrow points (Table 7). The rim measurements for Devil Point show a similar pattern of overlap between the point types.

Broad-Neck Projectile Points

Broad neck projectile points are described as lance, dart, or triangular shaped points in which the hafting method is side-notched, corner-notched or basally-notched. Broad-Neck points have been recorded at fifty localities within the North Santiam subbasin. Fifty-eight (88 %) out of the 66 projectile points were fashioned from obsidian, none from basalt, eight (12 %) from CCS (Table 8; Figures 56-59). Thirty-nine (67 %) of the obsidian projectile points were submitted for XRF and hydration analysis (Table 8).

A comparison of the Obsidian Cliffs hydration values associated with the broad-neck dart points and narrow-neck arrow points indicates that five of the dart point hydration rinds (0.8-0.9 μm) are thinner than the arrow point rim measurements, eight have similar rim thickness (1.0-1.4 μm) and nine are thicker (1.7-3.0 μm) than the arrow point rim measurements. This indicates that the dart point hydration rim measurements from the North Santiam subbasin show a strong correlation with the Middle Archaic into the Late Archaic period, based on a relative dating scheme.

Narrow-Neck Triangular Projectile Points

Triangular projectile points are described as point blades whose maximum width occurs near its base. The hafting method for these points may be unnotched, side-notched, corner-notched or basally notched. The triangular arrow points from the North Santiam subbasin are corner and basally notched with neck widths no greater than 7.5mm. These points have been recorded at 25 localities in the North Santiam subbasin. Twenty-four (89 %) of 27 arrow points from the subbasin were fashioned from obsidian and three (11 %) from CCS (Table 9; Figures 60-61). Twenty-one (89 %) obsidian arrow points were submitted for XRF sourcing and obsidian hydration (Table 9). Artifacts fashioned from Obsidian Cliffs material have rim measurements from 1.0 to 1.3 μm.

Two radiocarbon dates recovered from the Posy site (Burtchard 1990) indicate that the hearth features and associated arrow sized projectile points (n=3) date from 1100 to 1400 years ago. This site is located just north of the subbasin on a ridge top in the Upper Clackamas subbasin. Obsidian hydration results from feature related samples (Obsidian Cliffs material) link a bandwidth of 1.2 to 1.1 μm to that time period. The arrow-sized points had narrow hydration bands, indicating a relatively recent manufacture (Burtchard 1990: 176).

Discussion

A summary of the hydration rim measurements by point type and material is presented in Table 3. Although there is some overlap in the distribution of hydration values between the different artifact forms, the mean hydration values in general decrease in each obsidian type as one moves downward in the order.

Several lines of evidence point to early human use of the subbasin and the western slopes of Oregon Cascade Mountains. Artifacts manufactured from Obsidian Cliffs glass were recovered from pre-Mazama components 1, 2 and 3 at the Paulina Lake site which date from 11,000 B.P. to 7,000 B.P. (Connolly 1999: 159-161), and many of the stemmed artifacts from the North Santiam basin are comparable to Connolly's Variety 1 and 2 stem point subtypes. Paleoclimatic data suggest that conditions in the western Cascades were generally warmer and drier than present at all elevations and latitudes during the Late Paleo-Indian and Early Archaic periods, and there is a recognizable pattern in the large hydration rim measurements taken from the Western Stemmed points.

This evidence suggests that the High Plateau and Columbia Plateau people were accessing Obsidian Cliffs material or were in contact with those who had access to Obsidian Cliffs material by at least 8,500 years ago (Bergland personal communication) and more likely as early as 10,000 years ago. It also suggests that the Western Stemmed point is a much better chronological indicator for identifying early occupation in the western Oregon Cascade Mountains than the foliate point.

Indian use of the foliate point as a hunting tool extended from the Early Archaic period through the Late Archaic period based on a few radiocarbon dates and a wide range of rim measurements falling between 0.9 and 4.4 microns in the North Santiam subbasin. This broad range makes this point type a poor chronological indicator. The foliate point is the most common projectile point found through the North Santiam subbasin. The endurance of this early projectile point style throughout the Archaic could be a result of the broad definition assigned to this tool type. It also could be due to its versatility as a tool. This point type could have been easily reshaped into a different projectile point form; or many of them may have functioned as knives.

The data from Posy Ridge, coupled with the rim measurements for the dart and arrow points in the North Santiam subbasin, supports Connolly and Baxter's (1986) argument of the co-occurrence of the bow and arrow and atlatl and dart technologies in the western Cascade Mountains well into the Late Archaic. The data from the subbasin places the beginning of the Late Archaic closer to 1800 B.P., which is consistent with Minor and Toepel's (1987) chronology. The absence of side-notch arrow points, unlike the Upper Middle Fork of the Willamette may reflect a slightly more effective hafting technique than side-notching (Beck 1998).

Obsidian Cliffs is clearly the dominant material used for the manufacture of projectile points throughout the Archaic within the North Santiam Subbasin (Table 4 and 5). Indians made more use of Devil Point for the manufacture of projectile points than was expected due to the poor obsidian quality. The data do not appear to reflect a pronounced shift in source use for the production of tools throughout the Archaic with the exception that the use of Devil Point appears to have intensified during the Middle Archaic period.

Table 3: Average Rind Measurements for Projectile Points.

	Obsidian Cliffs	Devil Point	Carver Flow	Newberry Volcano	Juniper Springs Var. 1	Silver Lake Sycan	Med. Lake High	McKay Butte	Bald Butte
Stemmed Points	3.47 (1.3-4.9)	2.0 (1.0-3.0)	NVB	weathered				3.5	
Foliate Points	2.2 (0.9-4.4)	1.70 (1.1-2.55)		2.1	3.36				
Dart Points	1.62 (0.9-3.0)	1.22 (0.9-1.8)		1.38 (1.0-2.1)					2.4
Arrow Points	1.30 (1.0-1.8)	1.15 (.9-1.4)		1.0 (0.8-1.1)		1.1	0.9		

Table 5 shows that Devil Point material dominates some assemblages (Burtchard 1990; Werner et al. 1998) in close proximity to the source and dramatically decreases in use further from the source (Skinner 1997). The prevalent use of Devil Point obsidian suggests a prolonged pattern of acquisition through embedded procurement (Skinner 1997). Acquisition of Obsidian Cliffs was likely through trade or direct procurement. Obsidian Cliffs material is found in a variety of stages of manufacture in the subbasin suggesting that it was not derived strictly from trade.

To date all of the glass sources outside of the west slopes of the Cascade Mountains have occurred most often as finished tools. The third most common obsidian source represented is Newberry Volcano (5.8 %). The appearance of finished tools fashioned from this source material dramatically increases in the Middle Archaic and continues into the Late Archaic. The number of source materials found in the North Santiam subbasin does not change dramatically throughout the Archaic but the diversity of source material does. Obsidian source data suggest the possibility of contact with more southerly groups in the Late Archaic, or extended mobility with the introduction of the horse.

All of the points made from obsidian outside of the western Cascade slopes have been found along well-traveled routes. Eight of 18 exotic artifacts derived from Newberry

Volcano, Bald Butte, Juniper Springs, Medicine Lake Highland, and McKay Butte obsidian were located on ethnographically documented travel routes. Some artifacts sourced to Newberry Volcano and Silver Lake/Sycan Marsh were found along travel routes leading to the confluence of the North Santiam and Breitenbush Rivers, and in the vicinity of the Breitenbush Hot Springs. Figure 8 displays the distribution of projectile points types (excluding foliate) and exotic obsidian.

Table 4: Summary of Artifacts by Point Type and Lithic Material Source.

Source	Stemmed Points	Foliate	Dart Point	Arrow Points	Percent All Projectile Points
Obsidian Cliffs	9 (34 %)	19 (25%)	23 (35%)	9 (33%)	31 %
Devil Point	2 (7.7%)	18 (24%)	8 (12%)	3 (11%)	16 %
Newberry Volcano	1 (4%)	1 (1.3%)	5 (8%)	4 (15%)	5.8 %
Carver Flow	1 (4%)		1 (1.5%)	1 (4%)	1.5 %
Juniper Springs Var. I		1 (1.3%)			.5 %
McKay Butte	1 (4%)				.5 %
Silver Lake/Sycan Marsh				1 (4%)	.5 %
GF/LW Med. Lake Highland (California)				1 (4%)	.5 %
Bald Butte			1 (1.5%)		.5 %
Unknown Obsidian	1 (4 %)	25 (33%)	20 (30%)	4 (15%)	25 %
CCS	5 (19%)	9 (12 %)	8 (12 %)	3 (11%)	13 %
Basalt	6 (23%)	3 (4%)	-	-	4.6 %
Totals (n= 150)	26	76	86	26	

(Percentages in parentheses are representative of the total number within each column).

Table 5: Obsidian Source Material from Excavated Artifact Assemblages.

Site Number	Obsidian Cliffs	Devil Point	Carver Flow	Newberry Volcano	McKay Butte	Bald Butte	Quartz Mountain	Horse Mt.
<u>Cascadia</u> Cave	18	1						
<u>Ridgeline</u>								
35MA48	No Sourcing							
35MA68	7			1				
35MA22	25	4						
35LIN302	7	3						
35LIN301	17	14		2				
35LIN119	29	17		2				
35LIN515	55	7						
35LIN241								
35LIN525	38	3						
35LIN374		8						
35LIN252								
35LIN373	3	12						
35CL21	3	8						
35CL22	13			1			1	1
<u>Meadow</u>								
35LIN104	14	36						
35LIN105	26	77		1	1	1		
35LIN107	32	50		1				
35LIN321	14	33						
35LIN253	No sourcing							
35LIN186	No Sourcing							
<u>River</u>								
35LIN260	No Sourcing							
35MA49	No Sourcing							
35MA51	No Sourcing							
35LIN336	160	1						
Total	440	222		8	1	1	1	1

As will be demonstrated in Chapter Seven, many of the high-density site areas contain a range of artifacts suggesting repeated use of these areas throughout the Archaic. Further obsidian source and hydration analysis of archaeological site assemblages will provide more insight into the issue of mobility and direct or indirect procurement strategies.

Figure 8: Distribution of Point Types and Exotic Obsidian, North Santiam Subbasin.

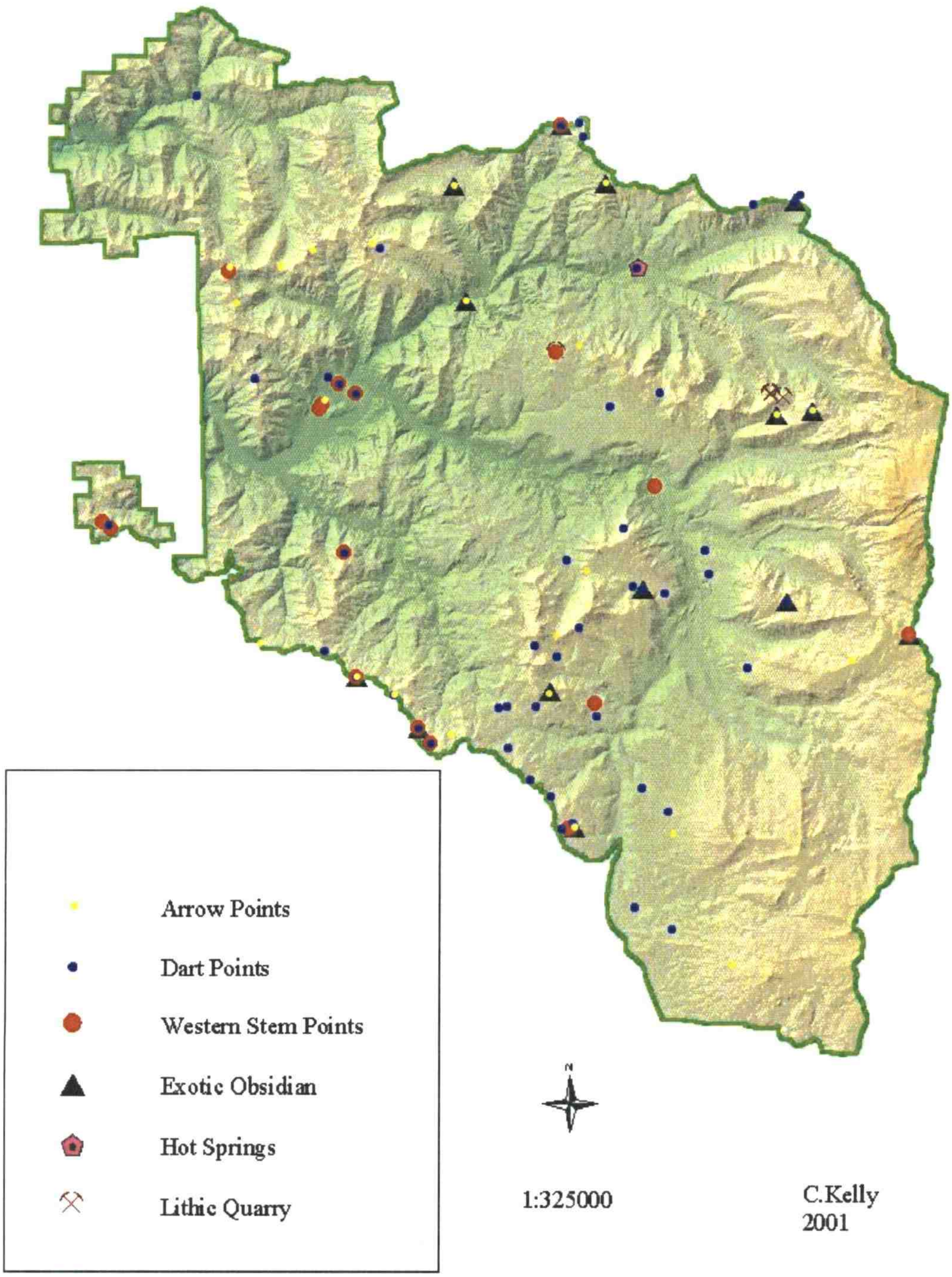


Table 6: Attributes of Western Stemmed Projectile Points, Bases, and Recycled Stemmed Points Collected in the North Santiam Subbasin (mm).

Site Number	Catalog Number	Length	Width	Thick-ness	Neck Length	Neck Width	Material Source	Hydration
04-016	FS-96			6		22.7	Basalt	
04-019	4-354	36		9		32	Obsidian Cliffs	3.5
04-019	4-357				16	17	CCS	
04-019	4-3071	42		7		20	CCS	
04-019	4-3068	60	20	6	12	15	CCS	
04-019	4-3069				15	18	Obsidian Cliffs	3.8
04-019	4-3121			5	40	18	Basalt	
04-019	4-363	27	23	6	19	18.5	CCS	
04-019	4-368	18		6		14	Devil Point	3.0
04-048	3-1-4	23	23		16	23	Basalt	
04-091	4-2932				14	19.5	Obsidian Cliffs	1.3
04-101	4-2435				24	30-25	Obsidian Cliffs	NVB
04-137	4-2065	34	19	7			Obsidian	
04-155	4-177			5	18	23	CCS	
04-191	4-572	31	29	8	23	23	Devil Point	1.0**
04-230	4-2225	16	23	6	16	23	Obsidian Cliffs	3.8
04-230	4-2232			3	17	13	Basalt	
04-230	4-2243			3	16.5	12.5	Basalt	
04-337	4-2054	57	22	10	15	13.5	McKay Butte	3.5
04-351	4-2784	22	24	8	20	23	Obsidian Cliffs	2.7
04-452	4-3113			5	12	19	Obsidian Cliffs	NVB
04-452	4-3121	40	19	6	13	16	Basalt	
40026	4-01	48	21	6	10.5	14	Obsidian Cliffs	4.9
40087	4-204	46	29	7	12.5	22	Carver Flow	NVB
40068	4-135				18	24	Obsidian Cliffs	4.3
40285	4-2029				15	20	Newberry Volcano	weathered

Table 7: Attributes of Foliate Projectile Points Collected in the North Santiam Subbasin (mm).

Site Number	Catalog Number	Length	Width	Thickness	Material Source	Hydration
04-006	4-2350	44	21	5	Obsidian	
04-016	FS-59	29	19	6	Devil Point	1.6
04-016	FS-231	46	35	16	Obsidian Cliffs	1.1
04-016	FS-11	87	31	10	Newberry Volcano	2.1
04-019	4-2667	42	19	7		
04-019	4-3070	40	23	8	Devil Point	NVB
04-021	4-02	37	17	5	Obsidian	
04-021	4-03	34	14	6	Devil Point	1.5
04-021	4-2	20	46	5	Devil Point	1.2
04-023	4-79	27	26	4		
04-023	4-202A	30	17	4	Obsidian Cliffs	1.1
04-023	4-225	34	25	5	Devil Point	1.1
04-029	4-3125	28	21	6	Devil Point	2.1
04-033	4-40	30	21	6	Obsidian	
04-035	4-2774	50	19	7	Obsidian	
04-036	4-339a	38	14	6	Obsidian	
04-052	884-1-77	42	16	5	Obsidian Cliffs	1.50
04-057	4-436	33	22	7	Obsidian	
04-057	4-445	32	10	5	Obsidian	
04-060	4-454	40	15	4	Obsidian Cliffs	2.4
04-061	4-09	37	20	7	CCS	
04-061	4-1929	41	27	4	Obsidian	
04-064	884-3-11	56	12	2.54	Obsidian Cliffs	0.99
04-065	884-2-160	30	23	5	Devil Point	2.55
04-065	884-2-139	34	16	5	Juniper Springs Variety 1	3.36
04-065	884-2-96	34	21	4	Obsidian Cliffs	2.80
04-065	4-2525	41	21	5	Obsidian Cliffs	1.08
04-065	4-270	42	16	5	Obsidian Cliffs	2.3

Table 7: (Continued).

04-065	4-269	35	21	5	Devil Point	1.2
04-065	4-230	33	13	5	Devil Point	2.3
04-065	4-333	37	19	5	Devil Point	1.1
04-076	4-195	38	14	6	Obsidian Cliffs	2.7*
04-082	4-372	49	19	6	Obsidian Cliffs	2.3
04-089	4-240	40	17	6	CCS	
04-089	4-153	27	17	6	Obsidian	
04-089	4-1837	22	20	7	CCS	
04-091	4-2267	64	22	10	Obsidian	
04-120	4-197	33	18	6	Devil Point	1.3
04-123	4-2795	61	18	6	Obsidian	
04-130	4-61	33	19	9	Devil Point	2.2
04-137	4-16	30	15	5	Obsidian Cliffs	2.4
04-137	4-37	39	17	5	CCS	
04-137	4-243	27	14	6	Devil Point	2.3
04-163	4-2892	44	17	7	CCS	
04-168	4-209	40	19	9	Devil Point	
04-180	4-2913				Obsidian	
04-208	4-1119	37	19	7	Basalt	
04-208	4-1121	57	23	8	Obsidian Cliffs	3.4
04-210	4-332	43	23	5	Obsidian	
04-210	4-532	73	27	10	Obsidian Cliffs	1.0
04-211	4-1884	56	25	13	CCS	
04-211	4-1885	48	17	7	Obsidian Cliffs	4.4
04-230	4-2234	40	14	3	Obsidian	
04-241	4-2112	35	11	6	Devil Point	2.2
04-252	4-2004	40	15	5	CCS	
04-375	4-2794	63	25	6	Obsidian	
04-335	4-2691	50	21	7	Basalt	
04-370	4-2780	53	27	8	Devil Point	
04-397	116	33	21	9	Obsidian Cliffs	2.6
04-397	4-2810	28	12	4	Devil Point	1.1

(Continued).

Table 7: (Continued).

04-397	120	60	25	7	Basalt	
04-402	4-2191	39	15	9	CCS	
04-444	4-3020				Obsidian	
04-444	4-2979	37	21	5	Obsidian	
04-447	4-3028	35	17	5	Devil Point	
04-452	4-3111	55	20	10	Obsidian Cliffs	1.1
04-466	4-3260	34	17	3	Obsidian	
40-084	4-198				Obsidian	
40-087	4-204a	69	25	7	Obsidian Cliffs	4.3
40-126	4-324	39	21	6	Obsidian	
40-129	4-327	55	21	8	Unknown	
40-160	4-388	53	22	10	Obsidian Cliffs	2.6
40-215	4-1120	80	26	10	Obsidian Cliffs	1.6
40-226	4-1961	51	26	8	Obsidian	
40-244	4-1981	54	24	7	Obsidian	
40-442	4-2969	38	22	5	Obsidian	

Table 8: Attributes of Broad-Neck Dart Projectile Points Collected in the North Santiam Subbasin (mm).

Site Number	Catalog Number	Length	Width	Thickness	Neck Width	Material Source	Hydration
04-009	4-530		20	4	13	Obsidian	
04-015	4-3140	36	24	7	13.7	CCS	
04-015	4-2136	36	21	6	9.5	Obsidian	
04-015	4-3139	26	21	6	10	Obsidian	
04-016	FS-151	34	26	6.5	14.7	CCS	
04-019	4-345	35	21	5		Obsidian Cliffs	3.0
04-024	4-491	25	15	4		Obsidian	

(Continued)

Table 8: (Continued).

04-033	4-3263		21	4.4	13	Obsidian	
04-042	4-3030	43	37	6		Carver Flow?	NVB
04-044	4-375	32	27	4	11.5	Obsidian Cliffs	0.9
04-048	4-419	34	24	6	8.4	Obsidian Cliffs	2.0
04-048	S-C-1	35	21	5	9	Newberry Volcano	2.1
04-052	884-1-110	66	34	7	18.34	Obsidian Cliffs	2.46
04-055	4-412	20	18	10	10	Obsidian	
04-057	4-441	24	21	4	15.6	Obsidian Cliffs	0.8
04-060	4-453	25	20	4		Devil Point	1.8
04-063	4-461	42	23	6	14.6	Devil Point	0.9
04-065	4-2612	29	14	4		Devil Point	0.99
04-065	884-2-4					Bald Butte	2.4
04-071	4-2630	71	32	8		Obsidian	
04-082	4-373	40	24	6	13	Obsidian	
04-087	4-2704	28	17	5	8	Devil Point	1.6
04-120	4-2399	30	19	4		Devil Point	NVB
04-130	4-60	45	26	9	24	Obsidian Cliffs	1.2
04-137	4-66	30	31	5	11.6	Obsidian Cliffs	1.4
04-137	4-70	335	17	4		Devil Point	1.0
04-145	4-1988	28	20	4	12	CCS	
04-153	4-183	61	25	7	17	Obsidian Cliffs	2.4
04-169	4-2992	25	18	5	10	Obsidian Cliffs	2.2
04-169	4-180	26	14	5	9.1	Obsidian Cliffs	1.0

(Continued).

Table 8: (Continued)

04-207	4-3145	31	27	7		Obsidian Cliffs	1.7
04-210	4-3122	42	29	6	16.4	Obsidian	
04-230	4-2231	50	26	5	13.7	CCS	
04-234	4-2721	30	22	7	11.5	Obsidian Cliffs	1.2
04-236	4-2171	36	21	6	14.2	Obsidian Cliffs	0.9
04-236	4-2175	26	22	5	11.7	Devil Point	1.0
04-282	4-2426	30	24	6	9.2	Obsidian	
04-312	4-2626	38	21	8	12.7	Obsidian	
04-337	119	60	21	10	17.1	Obsidian Cliffs	2.0
04-337	144	10	20	10	17.1	Obsidian Cliffs	2.2
04-337	146	41	32	7	20	Obsidian Cliffs	0.9
04-337	132	24	16	5.5	12.2	Devil Point	NVB
04-345	24	51	23	7	13.2	Obsidian Cliffs	2.6
04-354	1	66	32	8.1	23	Obsidian Cliffs	weathered
04-370	4-2780	53	27	8		Obsidian	
04-383	4-2916	42	34	7	14.9	Newberry Volcano	DH
04-391	4-2842	23	17	5	11	Newberry Volcano	1.0
04-397	57	29	18	5	10.3	Obsidian Cliffs	1.7
04-397	182	23	29	6	21.2	Obsidian Cliffs	1.9
04-397	180	39	20	8.5	14.2	Newberry Volcano	1.3
04-397	4-2804	17	26	5	17.5	Obsidian Cliffs	1.0
04-397	138	23	22	6	13.3	Jasper	
04-397	179	27	22	7	13.5	Chert	
04-398	4-2853	34	25	6		Obsidian	

(Continued).

Table 8: (Continued).

04-400	4-2861	35	30	8	17.9	Unknown	
04-447	4-3029	35	24	9	13.4	Newberry Volcano	1.1
04-467	4-3261	50	26	5	8.7	Obsidian	
04-091	4-2931	40	25	6	9.5	Obsidian	
40019	4-2200	22	21	4		CCS	
40059	4-90	32	23	4	11.4	Obsidian	
40086	4-199	70	30	8	21	Obsidian Cliffs	0.9
40103	4-221	53	36	7	17	Obsidian Cliffs	1.2
40168	40421	26	17	4	10.3	Obsidian	
40-316	4-2439		21	6	12	Obsidian	
40433	4-2968	37	22	5		Obsidian	
40443	4-2978	45	19	8	10.5	CCS	

Table 9: Attributes of Narrow Neck Arrow Projectile Points Collected in the North Santiam Subbasin (mm).

Site Number	Catalog Number	Length	Width	Thickness	Neck Width	Material Source	Hydration
04-016	FS-158	19	13	2	4.9	Obsidian Cliffs	1.3
04-035	4-339	19	12	3	4.8	Unknown	1.4
04-035	4-2775	43	16	6	7.4	Obsidian	
04-131	4-3117	29	15	5	7.2	Silver Lake/ Sycan Marsh	1.1
04-132	4-3001	30	15	4	5.5	Newberry Volcano	0.8
04-137	4-65	36	19	4	7.5	Obsidian Cliffs	1.4
04-187	4-2222	18	14	3	4.3	Obsidian Cliffs	NVB
04-193	4-2884	28	18	3	5.3	Obsidian Cliffs	1.0

(Continued).

Table 9: (Continued).

04-215	4-1976	12	12	2	4.7	Obsidian Cliffs	1.1
04-220	4-1945	14	14	3	5.9	CCS	
04-263	4-2049	15	15	3	4.7	Obsidian Cliffs	1.1
04-310	4-2594	18	10	3		Obsidian	
04-326	4-2655	18	13	3	4.4	Obsidian Cliffs	1.4
04-341	4-2854	21	18	3	2.7	Newberry Volcano	1.1
04-343	4-2715	16	10	3	6.7	Obsidian	
04-368	4-2765	22	13	3	5.2	Jasper	
04-387	4-2839	13	11	2	5.5	Jasper	
04-390	4-67	11	15	2	4.4	Newberry Volcano	1.1
04-391	4-2841	11	16	3	3.9	Devil Point	
04-391	4-2846	29	15	6	3.7	Carver Flow	NVB
04-400	4-2860	31	17	4		Obsidian Cliffs	1.3
04-402	4-2744	16	10	2	3.4	Devil Point	NVB
04-426	4-2957	20	16	6	7.5	Devil Point	0.9
40106	4-233	28	15	4	7.3	Medicine Lake	0.9
40178	4-536	37	17	6	6.2	Obsidian Cliffs	1.8
40318	4-2448	33	16	4	7.2	Devil Point	1.4
40460	4-3131	22	11	3		Newberry Volcano	1.0

CHAPTER 5
LAND-USE MODELS FOR THE WESTERN OREGON CASCADE MOUNTAINS

Introduction

Cultural resource surveys conducted on federal lands document a range of prehistoric sites. These sites are fragile and “nonrenewable” resources. Once a site is completely destroyed through modern development, much of the information regarding past human behavior is lost forever. The need to protect these fragile resources was acknowledged by the American public through the passage of numerous historic preservation laws and regulations.

The major thrust of these laws was a commitment to safeguard the country’s historic resources. The most significant piece of legislation that arose from the concern to preserve historic resources was the National Historic Preservation Act (NHPA). This Act, with later amendments, established the Federal Government’s policy on historic preservation and the national historic preservation program through which that policy is implemented. The passage of NHPA reflected the growing perception throughout the nation that through modern development we were losing something that everyone had reason to treasure: the character of our communities and our cultural roots, as expressed in historic properties.

The National Historic Preservation Act was passed in 1966, and amended in 1976, 1980 and most recently in 1998. In 1971 President Nixon signed Executive Order 11593 mandating all Federal agencies to inventory, nominate, preserve, and protect cultural resources. With the passage of NHPA and Executive Order 11593 the Forest Service in the late 1970s began to employ professional archaeologists to implement the program.

Land Management Plans' Standard and Guidelines were developed for each National Forest to ensure the proposed ground-disturbing projects would not inadvertently harm or destroy important cultural resources. The standard and guidelines specify procedures for complying with all mandates of Federal law, acts, executive orders, and federal regulations. These legislative requirements state that inventories will be conducted on all federal undertakings, sites will be recorded and evaluated for their potential to be nominated to the National Register of Historic Places (NRHP), eligible sites will be nominated to the Register, and management plans will be prepared to ensure their protection.

One of the responses to this legislation included predictive modeling of prehistoric land-use. The popularity of predictive modeling was based on the assumption that it would take years or rather decades for a comprehensive inventory of all archaeological resources on federal lands to be conducted (Kohler 1988:4). By creating formal models, managers would be capable of predicting where sites are located so that they may be able to understand and protect the sites.

Modeling

Sebastian and Judge (1988:1) define the term model by quoting David Clarke (1968:32): models are "hypotheses or sets of hypotheses which simplify complex observations whilst offering a largely accurate predictive framework structuring these observations." They point out two key aspects of the model definition: First, models are "selective abstractions, which of necessity omit a great deal of the complexity of the real world. Those aspects of the real world selected for inclusion in a model are assumed to be significant with respect to the interests and problem orientation of the person constructing the model...and that all models reflect, to a considerable degree, subjectivity on the part of the observer." Second, that "prediction is important, and that it is achieved scientifically through the generation of hypotheses that can be tested against the empirical record (Sebastian and Judge 1988:2)."

Warren (1990:202) points out three benefits of predictive models: 1) to provide archaeologists with a picture of prehistoric settlement patterns and the most important environmental determinants of site location; 2) to provide land managers with the expected determinants of site location; and 3) to provide project planners a preliminary assessment of the effects that future ground disturbing projects will have on archaeological remains.

Three environmentally based prehistoric land use models have been proposed for the western flanks of the Oregon Cascade Mountains (Baxter 1986, Snyder 1987; and Burtchard 1991). These models address several variables that are important for understanding the choices that groups made when deciding to select a particular site location in the upland Cascades. These three models provide a basis for addressing site location patterns in the North Santiam subbasin.

Mobility

Residential Mobility

Central to these models is the concept of mobility. Binford, with his ethnoarchaeological work with the Nunamiut Eskimos, first brought the concept of mobility into focus (Binford 1978). Two concepts commonly applied to hunter/gatherer strategies are residential and logistical mobility. Residential mobility is the movement of an entire band or local group from one camp to another (Kelly 1992:43). This type of mobility is what Binford terms forager, where groups "map onto" a region's resource locations (Binford 1980:Kelly 1992). Foragers make frequent seasonal residential moves to take advantage of resource "patches" (Binford 1980:5). A distinct characteristic of foragers is that they typically do not store food; instead they make daily short logistical forays away from the residential camp for food (Binford 1980).

Another distinct characteristic of foragers is that the size of the mobile group and the number of residential moves that are made each year may vary considerably (Binford 1980:5). In areas where there are relatively large resource patches, there may be more residential moves at shorter distances apart. This results in an intensive coverage of the resource patch (Binford 1980:5). However, if resources are scarce and dispersed, there will be a larger number of mobile groups (reduced in size) scattered over a larger area procuring resources (ibid: 6).

Binford (1980: 9) outlines two types of sites that will be generated by foragers: 1) residential bases and 2) locations. The residential base is the locus from which foraging parties originate. It is also the place where most processing, manufacturing, and maintenance activities take place. A location is a locus where extractive tasks are exclusively carried out (ibid: 9). These sites are usually low bulk procurement sites because forgers do not generally stockpile foods or other raw materials. Instead only limited quantities of food are procured during a particular foray and thus the site is occupied for only a short period of time (ibid). Binford notes that at these sites few if any tools would be expected to remain.

Logistical Mobility

Logistical mobility involves the movement of individuals or small task groups out and back to the residential camp. Binford (1980) refers to this type of mobility as collectors. According to Binford (1980:10) logistically organized collectors use specially organized task groups for procuring a specific resource in a specific context to bring back to the habitation site. Collectors are characterized by the storage of food for at least a portion of the year.

Logistical mobility involves a task group leaving a residential location and establishing a field camp from which procurement activities take place. The food may be processed at this location to facilitate transport back to the consumers at the residential camp (Binford 1980:10). According to Binford (ibid) these task groups are "generally small and composed of skilled and knowledgeable individuals." Collectors are not just out looking for any food they encounter, they are moving to known locations to procure specific resources. These resources are patchy, so a task group may be close to a crucial resource, but far from another important resource.

In addition to residential bases and locations, Binford (1980:10) recognizes three additional types of sites generated by collectors—1) field camps, 2) stations, and 3) caches. A field camp is a temporary operational center for a task group. It is here that the group sleeps, eats, and maintains itself while away from the residential base. There may be a variety of field camps based on the target resource (e.g. fishing camp or deer hunting camp).

A station is a site "where special-purpose task groups are localized when engaged in information gathering, for instance the observation of game movement or the observation of other humans (ibid: 12)." Stations may include hunting blinds or stands or ambush location from which hunting strategy may be planned but not necessarily executed (Ibid: 12). Caches are locations used by small task groups to temporarily store large bulk resources in the field prior to transporting them to the consumers at the residential base.

Based on the above, Binford (1980: 10) suggests that we can expect to find in the archaeological record residential bases, locations, field camps, stations, and caches generated by logistically organized settlement systems. Kelly (1992: 45) notes that the main difference between foragers and collectors is the "organizational relations between movements of individuals as individuals and movements as a group."

Logistical mobility is the concept commonly applied to the below discussions on proposed land-use models for the western slopes of the central Oregon Cascades.

Ecological Models for the Cascades

Baxter's Land-Use Model

Baxter (1986:160) proposes that prehistoric sites in the Central Oregon Cascades need to be placed into the larger perspective of a land use pattern by relating their location to the surrounding environment. He suggests that:

> The resources were distributed bimodally with respect to elevation, with most resources located in the lowlands. Other than large game, which was subject to a seasonal transhumance, all ethnographically described staples were lowland resources. Upland hunting and berry picking were part of the seasonal round, but the proximity of the upper elevations to the lowlands (less than 10km distance), and the logistics of transporting large amount of stored foods to the lowlands, suggests these excursions were common, but short term and task specific (Baxter 1986:191).

Baxter (1986: 42-47) suggests that in the Upper Middle Fork of the western Cascades, small moderately mobile groups conducted these excursions to procure the available resources throughout most of the year. He proposes that in the spring, multifamily Molala winter villages separated into small family groups to harvest the camas and other common resources in the small prairies scattered throughout the valley. Throughout the summer, hazelnuts, acorns, camas, grass seeds, ferns and other plant resources were harvested and processed for storage. These scattered low concentrations of very stable resources were able to support the subsistence and food storage needs of small groups.

By the mid to late summer, short term task-specific groups moved into the uplands to harvest and dry berries. Baxter (1986:163) predicts that the group's ability to transport the dried berries was more limiting than the actual availability of the berries. In the fall, families remained dispersed while they gathered acorns from the scattered oak trees and burned and collected the grass seed fields. By late fall and winter families gathered at the winter villages. Baxter proposes that the winter movement of deer and elk herds in the lower elevations may have made group hunting productive enough to support larger social units for a time before they relied on their stored winter supplies (Baxter 1987: 163). To date there is no evidence of large winter villages in the Cascade Mountain lowlands nor is there evidence of storage.

Baxter (1986) tested his ethnographic model by looking at the assemblages from nine components of four excavated sites in the Upper Middle Fork Drainage (Rigdon's Horse Pasture Cave, Vine Rockshelter, The Colt Site, and Saddle Sites). He then placed the four sites into a larger land use pattern by comparing the distribution of all site locations that were presently known in the upper Middle Fork area against the distribution of ethnobotanically meaningful plant communities. Six townships of the Upper Middle Fork were examined using the Oregon Archaeological Survey Records. A total of 123 prehistoric sites were recorded for that area. The sites consist of 110 lithic scatters of which eight were in rockshelters, 12 of which also contained ground stone implements. The other 13 sites were single or multiple rock cairn sites (Baxter 1986:165).

The distribution of sites by elevation indicates that ground stone is found almost exclusively at sites located in the lowlands (below 3500 feet) where plant communities include those resources considered staples (Baxter 1986: 177). Upland sites are associated with only two important resources: large summer range game and blue huckleberry fields. Instead of establishing upland summer base camps, Baxter argues that small task-oriented groups made frequent hunting and berry-gathering trips into higher elevations, returning with the procured resource to the lowlands. Baxter's (1986:165) model suggests a bimodal site distribution pattern with small task-oriented sites peaking at 5500 feet and lowland sites peaking at 2000 feet, and a break between the two peaks occurring at about 3500 feet.

Applying Baxter's land-use model to prehistoric use patterns for the Clackamas drainage, Snyder (1990:68) notes that upland sites should reflect a narrow range of activities instead of functionally diverse assemblages resulting from multiple tasks being performed at the same location over longer occupational periods. Snyder (1990: 69) points out that instead the bimodal pattern reflected in Baxter's model could indicate "a seasonally-related use of uplands and lowlands but with residential, or base camp, anchor points in each of these elevational zones." The resultant pattern may be a larger primary summer base camp surrounded by numerous more ephemeral, task-specific sites. These anchor points would be necessary if distance, topographic and/or biotic features made access from the lowland base camps to the upper elevations difficult (Snyder: ibid). In the Cascade Mountains topographic features would have made access to the upper elevations especially time consuming.

Recent test excavations at Site 35LIN515 (Draper et al. 1994:90) recovered a hopper mortar associated with a hearth feature that yielded a radiocarbon date of 2,930 +/- 80 years BP. The site is located at an elevation of 4050 to 4200 feet above sea level in a broad saddle on a ridge system that divides the North and Middle Santiam Drainages. Draper et al. (1994) concluded that the site functioned as a field camp or temporary residential site rather than simply a temporary camp. This was based on functionally diagnostic tools, the site's location and the hopper mortar associated with a hearth feature. The hopper mortar was found with the working side facing down, suggesting that the site occupants planned to return to the site the following year. Draper et al. (1994) proposed that hunting, butchery, and possibly some hide working took place at the site, along with the harvesting and processing of plant foods.

This interpretation of site function does not conform to Baxter's model that upland sites were not used as summer residential camps. It is highly possible that ground stone has been overlooked and that many of the larger sites in the uplands served as summer residential camps. There are several potential reasons why sites are not recognized as base camps in the Cascades: 1) Very few sites have been excavated in the uplands of the Cascades, 2) many of the sites are found in disturbed contexts so the ground stone is not recognized or has been removed; 3) plant processing likely involved the use of wooden tools that have not survived the acidic soils.

Snyder's Land-Use Model

In another land-use study of the Central Cascades, Snyder (1987) examined the relationships between human settlement and natural resource distributions by using a catchments analysis. In conducting her site location study, Snyder concentrated on those environmental features within the Cascades that are relatively more stable through time and which represent human resource focal points. These focal points are the non-forested areas (shrub and meadow communities discussed in Chapter 2) that offer predictable and long-lived areas of floral and faunal resource concentrations.

Snyder's (1987) study was conducted within a rectangular shaped area encompassing 860 square miles that crosses over the two physiographic provinces west and east of the Cascades within the Willamette National Forest and the Deschutes National Forest respectively. Only the results of the west side Cascades will be discussed here. Snyder's (1991: 121-123) database consists of Soil Resource Inventories which provide data on vegetation, soil type, drainage pattern, elevation, and other landscape features; archaeological site records (n=128) which provided the site locational data; and non-site locational data. The non-site locational data includes survey routes where no sites were observed. Site types were based on material evidence. These site types were identified as: a lithic scatter (isolated find or a more extensive scatter), rockshelter, rock cairn, and pictograph. Most of the archaeological site locations consisted of lithic scatters. Only rock cairns were recognized as a distinct functional subset of the archaeological sites due to the uncertain function of the lithic scatters.

Snyder (1991:124) used three units of measurement: 1) the actual site or non-site locations; 2) a 40 acre area or "cell" surrounding that point; and, 3) a larger circular zone encompassing up to a square mile around each point. These three units were viewed as a set of potential resource catchment zones. She used the chi-square statistic to measure whether any landtype occurred within site zones more or less frequently than would be expected by chance alone (1991:125).

The results of the chi-square tests indicated a significant association between sites and non-forest environments. Meadows on the west slope are widely scattered and rock outcrops were frequently found in direct association with non-forested wetlands. Also, high elevation mountain hemlock and fir, which occur on upper sideslopes and ridges, were found to be statistically associated with sites on the west slopes. Snyder (191:127) explains that this association is attributed to the presence of a series of sites associated with small lakes and wet, non-forest patches recorded along the ridgeline settings.

The lithic scatters (which make up the bulk of the site locations) were distributed in a bimodal pattern in which prehistoric sites in close proximity to non-forested wet meadows were restricted to elevations above 3500 feet and below 2500 feet. Based on this, Snyder argues for two basic montane land-use patterns pursued by members of a variety of cultural groups: 1) Semi-sedentary populations relying primarily on lowland resources that exploited upland game and berries as a supplement to lowland staples; and 2), Other wide ranging groups using the same basic resources for most of their dietary needs in a more mobile pattern. She stresses that the location of habitation sites and the movement of human populations are tied to the availability and abundance of critical upland plants and animals and these resources tend to be patchy rather than evenly distributed across the montane environment.

Snyder also argues for a bimodal site distribution pattern within the Santiam watershed and the western Cascades in general. In the Santiam watershed she notes that the greatest site frequency was found within 3500 to 4500 feet elevation, with a lower site frequency below 2000 feet.

Snyder (1991:130) notes that her analysis of site catchment zones supports "the broad parameters of the ethnographically based transhumance model employed by archaeologists in the Oregon Cascades, but also offers a more specific definition of resource distribution and site location patterns." She notes that the data "demonstrate a patchy distribution of economically important floral and faunal communities instead of a homogeneous distribution of upland resources (Ibid)."

Snyder indicates several factors that if incorporated into future studies, would produce a more complex model of resource distribution. These include calculating vertical distance or travel time within the catchment areas, strong chronological data, and an understanding of the site function. Another important aspect that introduces biases in her study is the lack surface visibility of the western Cascade slopes in forested settings compared to non-forested settings. She also notes that sample size, site recognition skills, relative amounts of exposed soils present within survey plots, or other conditions imposed on the data base may have biased results. However, she (1991:130) states that the above factors are "not considered powerful enough to invalidate" her conclusions.

Burtchard's Land-Use Model

Burtchard (1990) uses an ecological land-use model to explain prehistoric human use of the Central Cascades. He (1990:12) stresses the importance of understanding how Holocene climatic changes and increasing human population densities in the central Cascades impacted the availability of critical resources and consequently changed the human subsistence and settlement systems in the Cascades

To interpret the archaeological record he looks at adaptive requirements imposed on populations by the montane environment. Key to understanding his land-use model is the development of an extensive Northwest Maritime Forest with sub-zonal characteristics (Burtchard and Keeler 1991). Northwest Maritime Forest tends to achieve a mature state due to high humidity and relative environmental stability (Burtchard and Keeler 1991:17). As a mature forest develops it locks up a high proportion of the ecosystem's energy and nutrients in standing biomass of low species diversity. This low species diversity limits the available food resource for larger mammals, including humans, forcing them to direct their activities in areas where resources were locally abundant. These areas include anadromous fish-bearing streams and places where forests have not reached maturity such as meadows and alpine parklands (Burtchard and Keeler 1991:17).

Burtchard (1991:5) argues

> ...human groups will orient their activities toward locations that will maximize access to resources critical to their continued success... and that the organization of human systems and the manner in which they utilize the landscape is, in large measure, a response to the manner in which humans are obliged to 1) cope with practical problems of gathering critical resources from the environment, and 2) attempt to assure a stable supply of those resources overtime...in the face of variable climates and changing (generally increasing) population densities.

Based on the above environmental perspective, previous land-use studies (Snyder 1987), and site data from the Mt Hood National Forest, Burtchard (1991:5) proposes several hypotheses regarding the density of prehistoric sites and their correlation with different ecological zones: 1) the highest density of prehistoric localities will be on flat ground situated adjacent to anadromous fish bearing rivers and streams; on and near extensive upland ridge systems, at the fringe of open forest, parkland and timberline associations; on the fringes of perennially wet meadows, marshes and lakes; and at special material procurement sites such as cedar groves and lithic sources. 2) A moderate density of sites will be found on flat ground in areas where critical resources are more limited or ephemeral. 3) The lowest density of sites will be found on moderate to high slope landforms that lack the above resource characteristics (1991:60).

To investigate site density patterns, Burtchard (1991) examined a total of 210 (168 reexamined in the field) prehistoric localities and their relationship to five variables. The five variables include: 1) Slope, 2) Forest Landform Type, 3) Distance to Water, 4) Solar Exposure (aspect) and 5) Elevation. These variables are commonly used in modeling prehistoric localities and settlement pattern analysis (Kvamme 1985, 1988, 1989; Jochim 1976; Parker 1985; Warren 1990; Rose and Altschul 1988).

Slope

The site data indicate that over 85 percent of all sites are found on slopes of 12 degrees or less, and 95 percent of the lithic scatters are located on slopes of 10 degrees or less. Stacked rocks and peeled cedar trees were less constrained by slope.

Landform

In his model, Burtchard (1991:116) emphasizes a causal relationship between low maturity zones in the Maritime Forest and the patterned distribution of prehistoric lithic localities. These landforms include wet meadows, forest edges, ridge systems and saddles, and river terraces and floodplains. Stacked rock features are more likely to occur near rubble fields on mountaintops and slopes, ridges and upper valley slopes. Peeled cedar sites will be found where cedars grow the best: mountain and intermountain valley slopes, terraces and floodplains (Burtchard and Keeler 1991). The highest frequency of lithic sites (10 percent) and stacked rocks (9.7 percent) were located on ridge crests, with 7 percent on ridge saddles and 6 percent on ridge slopes. The floodplains contain the highest frequency of peeled cedar trees where moist habitat requirements are met (Burtchard 1991).

Burtchard (1991) attributes an absence of sites on mountain valley terraces to the narrowly incised tributary valleys and gullies making these landforms difficult to recognize or absent altogether. Sites were also absent on intermountain valley slopes and sideslope benches. Burtchard (1991) attributes this absence to the way the data were recorded; if a site was located on a slope not associated with a ridge system, then it was recorded as a mountain rather than a valley slope.

Distance to Water

There is a tendency for lithic sites to be located near water, with 28 percent located within 50 meters or less and 8 percent located within 100 meters. Peeled Cedar trees showed a clear association with water and stacked rock localities were primarily located at 200 meters or greater distance from water (Burtchard 1991).

Aspect

In terms of solar exposure the data revealed no patterned association between site density and exposure (Burtchard and Keeler 1991). Burtchard explains that this lack of patterning could be due to a variety of factors including the time of year the site was occupied or the configuration of storms.

Elevation

Burtchard argues for several patterns with sites associated with elevation. 1) Sites should be widely distributed across nearly the entire elevation range of the western Oregon Cascades in response to the widely distributed resource base. 2) There should be a higher density of sites located in the higher elevation ranges because of particular resource abundance, and 3) There should be more low elevation sites in areas providing an abundance of Anadromous fish. He suggests that these would be rivers located below the Willamette Falls.

Elevation is summarized using Snyder's (1991) site database that provides information on Smithsonian site identification number, site type and elevation. He divides the elevation data into two sample sizes, one north (northern Oregon Cascades) of the Santiam River and the second, south (southern Oregon Cascades) of the Santiam River. The North Santiam subbasin appears to be included in the Northern Oregon

Cascades, but this is not clearly stated. The elevation data indicate a bimodal pattern in the Northern Cascades with sites clustering at the 1,500 to 2000 feet elevation and again at the 4,500 feet elevation. Burtchard (1991: 112) notes that lower elevation clustering corresponds with major river drainages and the high elevation peaks encompass the elevation range of most of the western Cascade ridge systems. The southern Cascades elevation data indicate sites well distributed throughout the elevation range. Burtchard notes that the northern Cascade pattern may be biased by survey design and sample size.

Summary

Snyder, Burtchard, and Baxter's ecological models address several variables that are important for understanding what resources were available to groups and the choices that these groups made when selecting a particular site location. Their main focus is on the physical strategies and critical resources crucial for population survival.

Baxter predicts that resources were distributed bimodally with respect to elevation and that all ethnographically described staples were lowland resources, with the uplands supporting big game and huckleberry fields. Snyder's model predicts significant site clustering near upland lakes and wet meadows along ridgeline settings. Burtchard anticipates that human groups will choose to locate their activities in areas that will maximize access to critical resources.

All three support a bimodal site distribution pattern in the Central Cascades. Baxter suggests small task-oriented sites peak at 5500 feet and lowland residential sites peak at 2000 feet, with a break between the two peaks occurring at about 3500 feet. Snyder argues that the greatest site frequency was found within the 3500 to 4500 feet elevation in the Santiam drainage, with a lower elevation peak at below 2000 feet. Burtchard supports Snyder's findings and suggest that the lower elevation clustering corresponds with most major river drainages along anadromous fish bearing streams, and the high elevation peaks encompass the elevation range of most of the western Cascade ridge systems.

Central to model development is the testing of the models. I will be testing all three models and trying to expand on them using ArcView Geographic Information Systems Spatial Analyst and data gathered from the North Santiam subbasin. GIS offers an opportunity to look at human land-use patterns from broader perspective using a much larger database than was initially used to create the models to be tested. It allows me to study land-use patterns because it can organize the data (environmental and archaeological) in ways not possible before, thus allowing new insights and perspectives to be gained on the broader distribution of prehistoric sites and their association to particular ecological zones within the North Santiam subbasin.

CHAPTER 6
RESEARCH METHODS

Introduction

Predicting site location through model development is based on the assumption that human behavior is patterned and that the outcomes of the decisions that people make about where and where not to live are also patterned (Rose and Altschul 1988:175). Human groups make a decision to accept or reject a given location for its performance of an activity based on a complex assessment of the location's properties.

Predictive models of site location may be intuitive, deductive, or inductive. An inductive model usually begins with data and then builds its conclusions based upon all the biases inherent in the original data set. Deductive models begin with a theory predicting human behavior. However, in practice, the best models make use of both theory (deductive) and empirical observations (inductive) (Warren 1990; Kohler 1988). Purely theoretical models cannot be implemented or tested without observation and purely inductive models of site location are uninterpretable without theory.

This study is based on several assumptions. It is assumed that 1) sites are not randomly distributed across the landscape; instead, prehistoric human groups chose particular activity locations based on the natural environment, 2) these environmental variables have survived to modern times and are represented by the presently available data, and 3) that correlations between known archaeological site locations and the natural/physical environment observed by modern researchers reflect land use choices made by prehistoric decision makers (Warren 1990).

The objective of this analysis is to test applicable portions of the three land-use models (Baxter 1986; Burtchard 1991; and Snyder 1987) outlined in the previous chapter and determine which environmental and social strategies were important to prehistoric groups when deciding where to place a site in the physical environment. The purpose is to predict where sites are most likely to be found during archaeological surveys within the North Santiam subbasin to help guide land management decisions in the protection of cultural resources and to contribute to the local and regional prehistory by generating new hypotheses regarding observed patterns of human behavior. The present study addresses the following questions using the Detroit Ranger District's site, environmental, and social GIS coverages (discussed below).

- Does the site density pattern in the North Santiam subbasin reflect one or a combination of all three models present in Chapter 5?

- All three models predict site clustering at particular elevations. Is there a bimodal distribution of sites by elevation in the North Santiam subbasin? If not, where are sites cluster in the North Santiam subbasin? If there is a bimodal distribution, how does this distribution correlate with the three vegetation zones outlined in Chapter 2?

- Are the high-density site areas associated with perennially wet and moist meadows, lakes and ponds, and huckleberry patches? Where are these types of non-forested communities located within the major vegetation zones and by elevation?

- Is there a higher percentage of sites located on flat ground situated adjacent to Anadromous fish bearing rivers and streams; on and near extensive upland ridge systems; and at special material procurement sites such as cedar groves, and lithic sources?

- Are there topographic factors that might work either to enhance or inhibit ease of access to particular upland locations?

- How does the location of prehistoric sites relate to the known historic trail locations?

Archaeological Field Methods and Results

Survey Methods

Archaeological data collection on the Detroit Ranger District began in the mid-1970s as a result of legislative requirements. Between 1975 and 1981, inventory on the Detroit Ranger District was confined to unit-based or project specific surveys in which only those areas to be affected by timber harvest, road construction, and other ground disturbing activities were searched for cultural resource sites. Many of these early surveys were accomplished by non-systematic transects within the proposed project areas and were not based on prediction or probability of site location. Instead, district personnel would often collect some data on site locations encountered in the field while accomplishing their other duties, seldom covering 100 percent of the high probability ground.

Beginning in 1983, Detroit Ranger District hired an archaeologist to conduct the field survey. Sites were recorded by conducting systematic surveys for a broad range of ground disturbing projects and from informants on and off the district who provided information about site locations. Systematic surveys involved covering 100 percent of high probability ground and twenty percent of low probability ground for the occurrence of archaeological remains within a specific project area (defined below).

All areas where at least one key natural or cultural element is present are designated high probability zones (Davis 1988). Key natural elements include ridge tops, saddles and midslope benches along ridgelines, meadows, springs, stream headwaters, stream confluence, large rock outcrops, ponds, lakes, cedar groves, and streamside riparian zones. Slope, aspect, elevation and the presence of trails also have an influence on site location. Cultural elements include all known and recorded site locations, unverified site locations, and isolated finds. All other areas are designated as low probability zones (Davis 1988). Low probability zones typically occur in areas with steep slopes or gentle undulating terrain, lacking water.

In 1988, this systematic survey strategy was formally adopted as the Cultural Resource Inventory strategy for the Willamette National Forest (Davis 1988). The strategy focuses on broad area surveys for all proposed ground disturbing projects. The broad survey areas include "both the proposed impact areas, such as timber sale cutting units, and a representative sample of lands adjacent them (Davis 1988:20)". For a timber sale, the broad survey areas are delineated around each timber harvest unit with reference to prominent natural features such as a ridge system and or drainage. Once the broad area survey boundaries are determined then the project areas are stratified into low and high probability zones.

In the field, all high probability zones are subject to an intensive 100 percent search using parallel survey transects spaced 15 to 20 meters apart. This close spacing is necessary because of the small lithic scatter sites that occur in the Cascades. Surveyor transects spaced further than 20 meters apart will run higher risk of missing sites (Plog 1978). Survey transects vary depending on the type of terrain. In the gentler terrain straight compass oriented transects are followed. However, in the more rugged and steep terrain meandering transects following the contours of the land are used. Every 20 to 30 meters within the high probability zones, surveyors use a shovel to expose a surface area of 1-x-1 m down to mineral soil. This is done with greater frequency in locations more likely to contain archaeological remains such as saddles, midslope benches, and areas surrounding meadows. Using a shovel to expose mineral soil works in most areas on the forest. Nevertheless, there are areas with thick shrub cover making surface scrapes difficult to impossible.

Archaeological Site Surface Data

Following the above survey strategy, the number of sites located and recorded began to increase beginning in the mid 1980s. Ten artifacts or more within a 1-x-1 m square area represents a site, as defined by the Oregon State Historic Preservation Office. However, there are some areas where only 3 artifacts may have been located and designated a site, or ten artifacts that may be spread across a 5-x-5 m square. This site designation is based on the topographic circumstance, the environmental context, the cultural context, and the degree of surface visibility. Defining a site prior to survey is critical in order to produce a database of sites that are comparable (Plog 1978:385).

Approximately 46,000 acres (17 percent) have been surveyed on the Detroit Ranger District resulting in over 400 recorded prehistoric sites, 455 prehistoric isolated finds, and 100 historic sites. The prehistoric sites include lithic scatters, rock cairns, peeled cedar trees, rock shelters, caves, raw material sources and trails. Historic sites types include trails and associated telephone lines, bridges, railroad grades and camps, Civilian Conservation Corp era camps, highway construction camps, homesteads, guard stations, lookouts and garbage dumps. This study focuses on the recorded prehistoric sites.

A large percentage of the lithic scatter sites have been mapped to scale using a hand-held compass and metric tape measure and tied to established datums. Only recently has Global Positioning System (GPS) been used to map sites. The artifact collection strategy on the Willamette National Forest includes collecting all diagnostic artifacts, which to a large degree have been point provienced. No other artifacts are collected. This collection method makes it difficult to assess site function, a crucial element in interpreting the role of each site located across the district. For this reason site function will not be addressed in this study.

A site record form and an Oracle database site form (McAlister 1990 revised 1993) are filled out while recording the site in the field. All artifacts are analyzed using the oracle data base Lithic Tool Data Form and Debitage Data Form (McAlister 1990 revised 1993).

Biases in the Site Survey Data Affecting the North Santiam Model of Land-Use

Several biases potentially exist in survey databases that are a result of many years of inventory conducted by several different surveyors (Kvamme 1988:304-308). These biases are important to address because they affect the outcome of a predictive model.

Survey in the western Cascades is not an easy task and discovering a site is even more challenging due to several factors. The most obvious deterrent to survey and site discovery is the very dense understory brush and thick duff layer of moss and needles. Many areas support thick ground cover of salal, Oregon grape, beargrass, ferns, rhododendron and huckleberry. There can be days in the field when you feel that all you can find are large rhododendron patches and you begin to wonder if you have forgotten what an artifact looks like. Coupled with the vegetation is the fact that most sites in the Cascades are small, consisting of scatters of lithic artifacts. Other factors affect how crews perform fieldwork and the quality of their fieldwork, and these include adverse weather conditions (heavy rains or extreme heat); insects (mosquitoes or yellow jackets); terrain (steep rugged slopes); crew tiredness or mood.

Crew spacing has a direct affect on the intensity of the field survey. As mentioned above, if surveyor transects are spaced far apart then there is a high risk of missing smaller sites. Surface scrapes and shovel probes can help in areas of thick vegetation. However, this method usually will only locate denser lithic scatters. Taking advantage of all areas of exposed soil (e.g. rootwads, trails, fire lines, dirt roads, river and road cutbanks) is also crucial for discovering sites. Planning surveys during the months of May through September when the sun is high in the sky creates optimum light conditions.

This is particularly important when surveying under a forest canopy. All of these biases must be taken into account when developing a model of site location.

One of the most apparent biases is the variation in which different archaeologists and field crews perform fieldwork and define, identify, and record archaeological sites. This is evident when comparing site reports and inventory reports from the late 1970s and early 1980s to those from the last 15 years. Early site record forms do not always provide detailed descriptions of artifacts found on the site, environmental data or an adequate site location map. Site monitoring and updating site information on many of the early recorded sites has helped reduce this bias. Eliminating those sites records with poor locational information can also help reduce bias when developing or testing a predictive model (Kvamme 1988).

Survey routes depicted in the earlier inventory reports did not cover 100 percent of the high probability ground. The reason for the lack of coverage is that many of the surveyors were often just collecting some data on site locations encountered in the field while accomplishing their other duties. Another bias may include an uneven distribution of survey across the District. Some watersheds or environmental communities on the district have been more extensively surveyed than others because surveys are project driven. This may bias estimates of site density in watersheds with less survey data.

When conducting research in the Cascades it is important to take into consideration formation processes and their effect on the archaeological record (Schiffer 1987). Formation processes are the cultural and natural processes that affect the context of artifacts and features and how they are associated on a site between the time they were used and then deposited to the time they were recovered by archaeologists.

Natural Formation Processes will influence surface finds and excavation by adding things to the archaeological record that shouldn't be there or by taking things away that should be in the record (Schiffer 1987). Some of the more important ones that need to be considered when working in the Cascades include bioturbation, floraturbation, tree blow down, the heavy rainfall and snow packs (over 100 inches annually), which promote severe decay and the erosion of artifacts and sites, and freeze/thaw cycles (Schiffer 1983). All of the natural formation processes have the ability to expose archaeological materials to the surface; thus models based on environmental correlation may be predicting where we see sites rather than how people behaved. Known site locations may not always reflect where sites are located but where people have actually looked for them or whether depositional and post-depositional processes have exposed the material remains. Cultural formation processes include the numerous ground disturbing activities that have exposed many of the sites in the subbasin. These include timber harvest activities, forest fires (may also be natural), road construction, and recreation developments.

Geographic Information Systems Data

In the 1990s, Geographic Information Systems (GIS) was introduced to the District. GIS provides a comprehensive system for the management of large diverse, geographic data sets obtained from a variety of sources. It is a unique computer system designed to efficiently capture, store, update, manipulate, analyze, and display all forms of geographically referenced information (Berry 1993, 1997;Chou 1997). What makes GIS unique is its ability to incorporate essential elements of computer cartography and relational databases into one system. Within a GIS each mapped entity is linked to a record in a tabular database and may be related to records in other databases. The linkage between the relational databases and the cartographic maps allows the analysis of geographic data (Clark 1997). The integration of these two technologies in GIS creates "intelligent maps" and the ability to perform spatial analysis (Clark 1997).

This new capability allowed the district to begin focusing on large integrated resource planning areas called watersheds. The intent of a Watershed Analysis is "to develop and document a scientifically based understanding of the processes and interactions occurring with a watershed". The district began analyzing the entire watershed in order to describe the dominant features and physical, biological and social processes relative to their geographic and geomorphic setting. In order to develop an understanding of the physical and social realms of the watershed an intensive field reconnaissance and review was necessary. This type of analysis provided the opportunity to conduct very broad area cultural surveys within each watershed instead of unit specific timber sale surveys.

The introduction of GIS on the district has provided a more efficient way to manage the growing archaeological database collected over the past 20 years. Since 1990, the district has digitized all recorded cultural resource sites, unverified site locations, isolated find locations, survey coverage, and known historic trail locations. Information for each site record form has been entered into an Oracle database, which can be linked with information in GIS. This information includes site type, legal description, universal transverse mercater (utm), environmental information, slope, aspect, site size, landform, elevation, distance to water, and artifact types and material. This district also has an extensive GIS database of primary coverages for soil, meadows and other non-forest types, vegetation, and hydrology (Class I-IV streams, ponds, lakes, springs). A Digital Elevation Model (DEM) composed of regularly space points with x, y and z values is available for generating an elevation, slope and aspect layer. The accuracy of the DEM is extremely important because it controls not only the quality of the overall landform representation, but also the nature of all the secondary data types derived from it (Kvamme 1990:113; Marozas and Zack 1990:166). All digitized data are referenced within GIS to a common geographic coordinate base, the Universal Transverse Mercator grid.

One of the most widely used applications of GIS in archaeology has been for modeling prehistoric site locations or predicting where sites are located across the landscape (Warren 1990, Kvamme and Kohler 1988, Kvamme 1989, Dalla Bona 1996). This approach involves using map overly techniques using GIS. The different variables are represented on separate computer map layers, and these map layers are combined in ways that identify areas spatially associated with valued landscape characteristics. Different combinations of variables give rise to various stages of the predictive model.

GIS also allows information such as elevation, slope, aspect, local relief, proximity to water, and landform features to be displayed using computer graphic/cartographic techniques. These maps can be produced quickly and accurately, incorporating uses of color, shading, and a three-dimensional perspective that is unavailable in conventional cartography.

Potential Problems with GIS

There are potential problems with using GIS for predictive models for determining site locations. First, data entry and data processing can create a faulty elevation file resulting in a poor representation of the actual landscape (Warren 1990). Second, site presence probability may be multimodal along some interval scale variables (i.e. distance to water) (Warren 1990). Third, rare categories of nominal-scale variables are poorly represented. These categories are potentially unstable and unreliable in the same manner that low expected frequencies are unwanted in a chi-square test (Warren 1990: 212-213).

A fourth problem was identified by Carmichael (1990) who used GIS to model predictively prehistoric site location for a relatively large area in north-central Montana. He found the most challenging aspect of the study was dealing with the variability in quality and quantity of data available on archaeological sites in the region and how to make them comparable.

The following section describes the procedures for addressing land-use patterns in the North Santiam subbasin. This study examines the roles of the particular environmental and social variables used to test the three land-use models and how they might influence human decision making in settling in a particular location.

The Present Study

There are many factors that may have been important to prehistoric inhabitants when deciding where to locate a site. For this study, several independent variables are used to address favorable site locations and are considered non-archaeological characteristics of locations. These variables reflect relatively stable landscape characteristics through time and across space (Dunnel and Dancey 1983). This helps to insure that there is some conformity between modern map-measured data and the prehistoric environment. The following discusses each environmental variable and its relation to human settlement. These variables are commonly applied when modeling prehistoric site locations or conducting settlement pattern analysis.

Environmental Variables

Elevation

Elevation is one of the keys variables used in the existing Cascade Models. In the Cascades it is considered a better indicator of site type and function than site occurrence (Davis 1987). Elevation affects the timing of the ripening of resources and the pattern of big game movement and other faunal resources. During the fall, prehistoric groups would have been attracted to higher elevation stream terraces, mountain benches and ridge systems for fall hunting and berry picking as opposed to the lower elevations which would have been inhabited during the winter months within or near the wildlife winter range.

Aspect

Aspect is an important factor that may have conditioned human settlement in the Cascades. The availability of sunlight can help reduced both damp and cold and served to dictate where many prehistoric campsites were located, especially since rain and snow are common throughout much of the year in the interior mountain valleys of the western Cascades.

Slope

Few prehistoric sites are located on land features that are especially steep, rocky or otherwise difficult or dangerous to access. Slopes greater than 35 percent typically do not contain sites. For this reason, slope conditioned prehistoric human settlement on the landscape.

Landform

Seven descriptive attributes were used to categorize local topographic data: floodplain, lake basin, midslope bench, stream confluence, stream headwaters, toeslopes and topslope. Landform may be a proxy for consideration of defense, religious purposes, floral resources, travel or any other reason that a group may have for choosing a place to live or to conduct activities.

Vegetation: forested vs. non-forested

Dispersed across the three major vegetation zones are a series of non-forested communities. The current land-use models for the Cascades predict that these non-forested communities are critical resource gathering areas for hunter-gatherer groups.

If these special habitats (Meadows and huckleberry patches) served as important resource procurement areas in the North Santiam subbasin for past human groups, then the archaeological recorded should demonstrate a bias toward some, if not all, of these non-forested communities.

Water

The importance of water to hunter-gatherer site location is widely accepted. Settlement studies most often examine distances to a variety of water sources, such as permanent rivers, seasonal streams, lakes, ponds and springs. The abundance of water in the Cascades suggests that the placement of archaeological sites may not have been influenced strongly by the location of water sources. Permanent water sources include rivers, streams, lakes, and ponds where water is available year-round. The Nearest water source includes all of the above. The Rivers and Streams are classified by I, II, and III order. Class I are perennial streams used by anadromous fish for spawning, rearing or migration and are the direct source of water for domestic use. Class II are perennial streams used by non-anadromous fish for spawning, rearing or migration; and Class III are perennial streams which do not meet the higher-class criteria. Class IV streams are intermittent and were not included because of the uncertainty of their age.

Social Variables

Three social variables are used in this study, distance to trails, hot springs, and rock cairn sites. The ethnographic data suggests the importance of trails for travel throughout the Cascade Mountains. If the ethnographic record is accurate, then sites should be located in close proximity to trails. The hot springs is also mentioned in the ethnographic record and in conversations with some of the Warm Springs elders for medicinal use. Rock cairns are thought to represent areas where males undertook vision quests.

GIS Methods

This analysis was conducted using ArcView Spatial Analyst, a product of ESRI Corporation. Spatial Analyst is an extension for ArcView that provides raster functionality within the ArcView interface. This extension is based on ARC/INFO Grid module and allows operations such as Map Algebra, Surface analysis, Hydrologic and Viewshed analysis.

Grid is based on map-algebra concepts, a data manipulation language specifically for geographic cell-based systems (ESRI 1996). The algebra is a high-level computational language for describing cartographic spatial analysis using grid maps. Using the map-algebra and the GRID tools the user is able to solve a wide range of spatial problems from single simple queries and display problems to more complex problems (ESRI 1996).

Two factors are essential when working in GRID: 1) the resolution of the grid cell in a study area, and 2) the registration of the grids. The size chosen for a grid cell of a study area depends on the resolution required for the most detailed analysis. It is important that the cell size is small enough to capture the required detail but large enough so the computer storage and analysis can be performed efficiently (ESRI 1997). Grid registration is essential prior to completing any analysis or processing between multiple grids. All input grids must be in the same planar coordinate system. The data used for this study were all registered using the Universal Transverse Mercator coordinate system.

GIS Layers

To test the three models the analysis began with a total of six GIS vector layers and a Digital Elevation Model (DEM). The DEM data files are digital representations of cartographic information in raster form. The DEM maps used on the Willamette National

Forest are level one 7.5' DEMs that have been acquired photogrammetrically by manual profiling or image correlation techniques from the National Aerial Photography Program (NAPP). These have been digitized at the 10-meter contour level providing a good representation of the actual landscape (Figure 9). The six layers include vegetation, historic trails, streams, lakes and ponds, cultural sites, and cultural surveys. The soils layer was not included in this analysis because the vegetation layer and the elevation grid provide more accurate information on vegetation type and elevation.

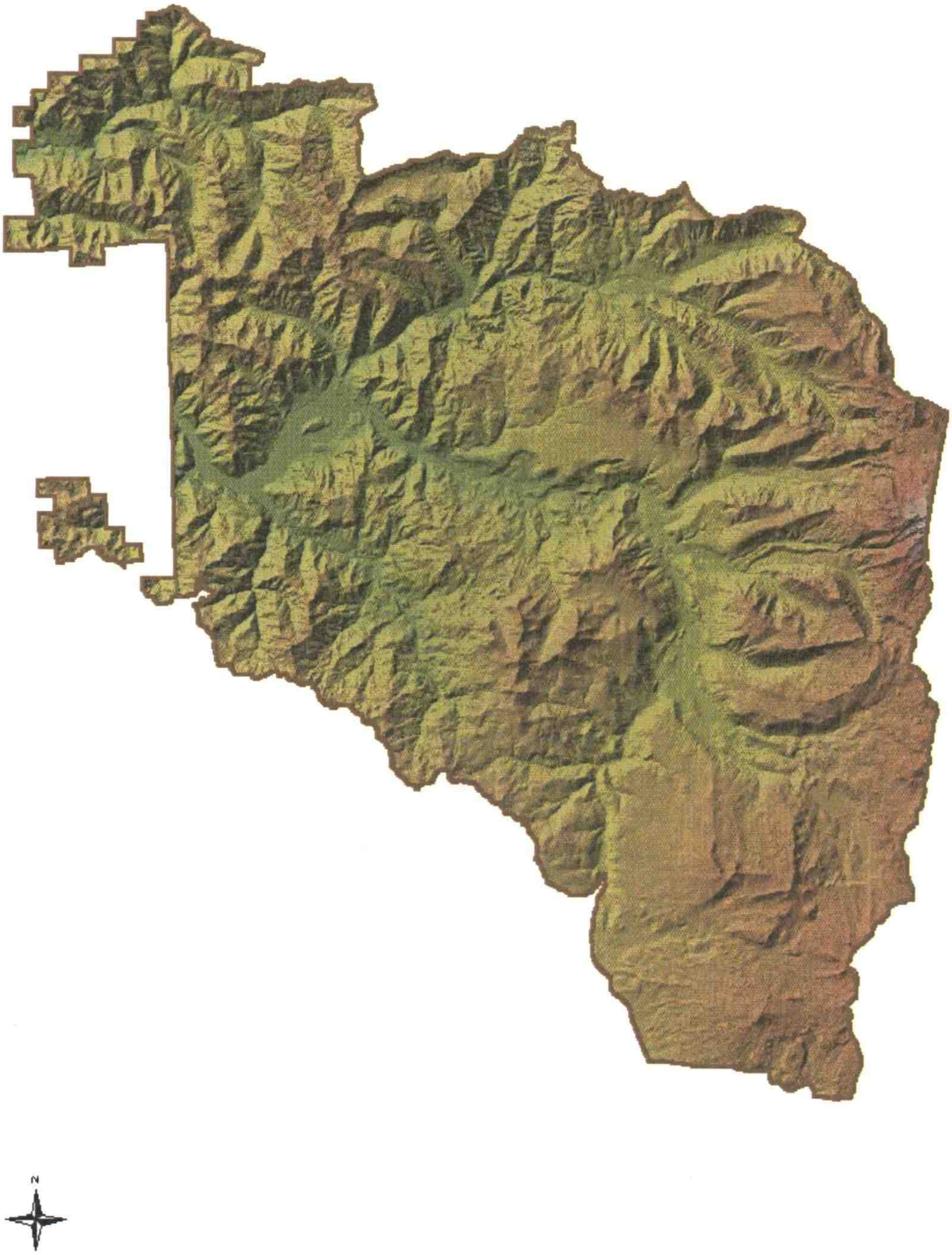
Data Manipulation

Testing the three land-use models required testing the relationship between the various environmental variables and site locations to determine if there is a pattern in the distribution of sites in the North Santiam Subbasin. To test this relationship, each independent variable was subjected to a chi-square test to determine if the sites are associated more often than expected with the various independent variables. Chi-square test for significance was used because there were more than two categories for each variable. The null hypothesis states that sites are randomly distributed throughout the North Santiam subbasin.

Using the distance to meadow layer as an example, the questioned posed is whether or not the discrepancy between the observed site locations and the expected site locations was a result of random distribution of sites in relation to the meadows. Several steps were conducted within Spatial Analyst prior to implementing the chi-square statistical test.

To begin, the Detroit Ranger District Boundary was clipped from the larger Willamette National Forest DEM. Then, the analysis environment was set which involved setting the extent, cell size, and mask to the boundary of Detroit Ranger District. Each vector layer was then converted to a grid using the same extent and cell size (10 meters) as the Detroit Boundary mask so that they would line up during the analysis.

Figure 9: Detroit Elevation, North Santiam Subbasin.

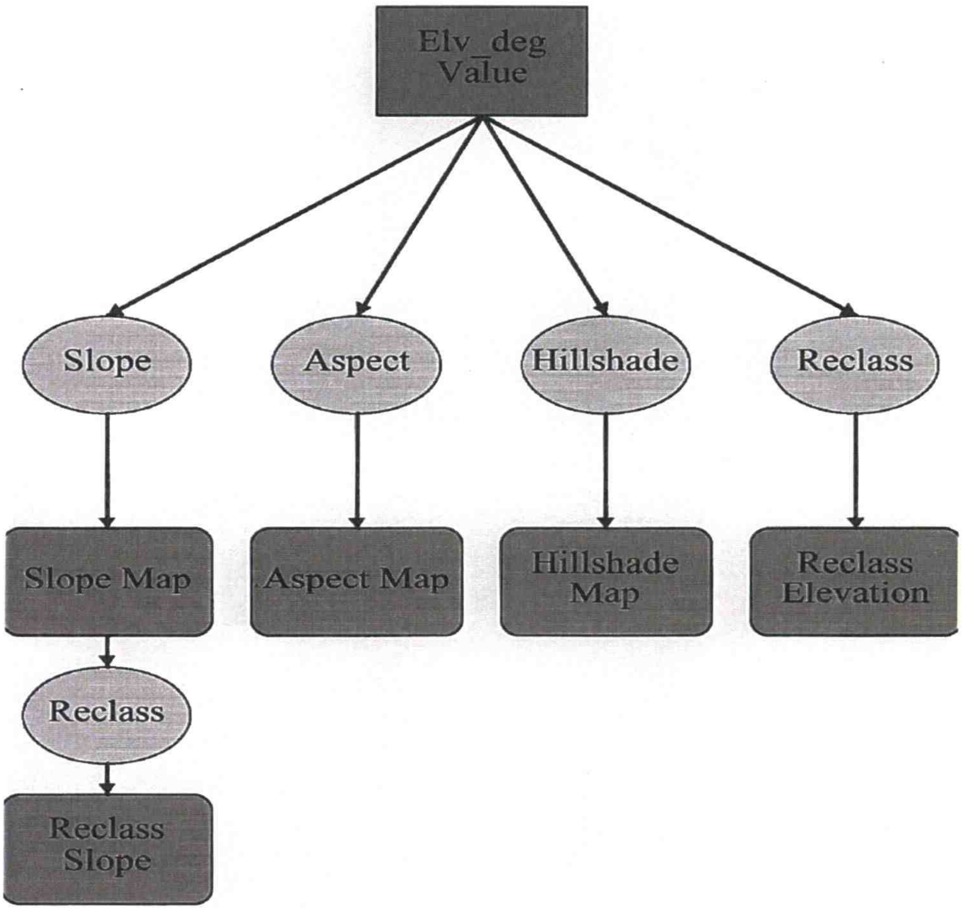


1:325000

C.Kelly
2001

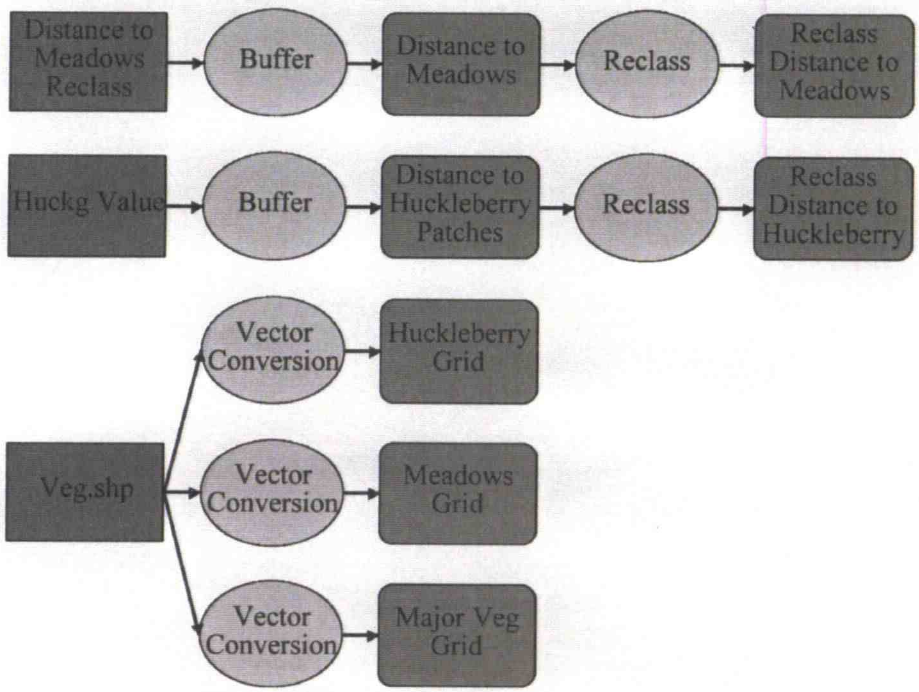
Using the Detroit Elevation Grid (DEM) two continuous grids were created: Aspect and Slope in Percent. The slope and elevation grids were then reclassified in 12 discrete increments to provide comparison with the proposed Cascades models that indicate a bimodal site distribution by elevation. From the Vegetation layer three new grids were created: Major Vegetation (Western Hemlock, Pacific Sliver Fir, and Mountain Hemlock), Meadows (wet, dry, moist, and subalpine), and Huckleberry patches. Figures 10 and 11 provide a flow chart of the process followed to create these grids.

Figure 10: Flow Chart of the GIS Process



The next step involved creating a distance grid from each of the following grids: Meadows, Huckleberry patches, Historic trails, Streams (class I, II, III), and Lakes and Ponds. The distance function makes straight-line measurements from cell center to cell center and determines how far each cell is from the nearest variable, such as meadows. The effects of slope are not considered during this process. After each distance grid was created, they were then reclassified into 12 discrete 100-meter distance intervals. The distance grid was chosen to test whether or not prehistoric sites are found on the fringes of meadow, lakes, huckleberry patches, trails and perennial fish bearing streams and at what distance (if any) do the site frequencies drop.

Figure 11: Flow Chart of the GIS Process



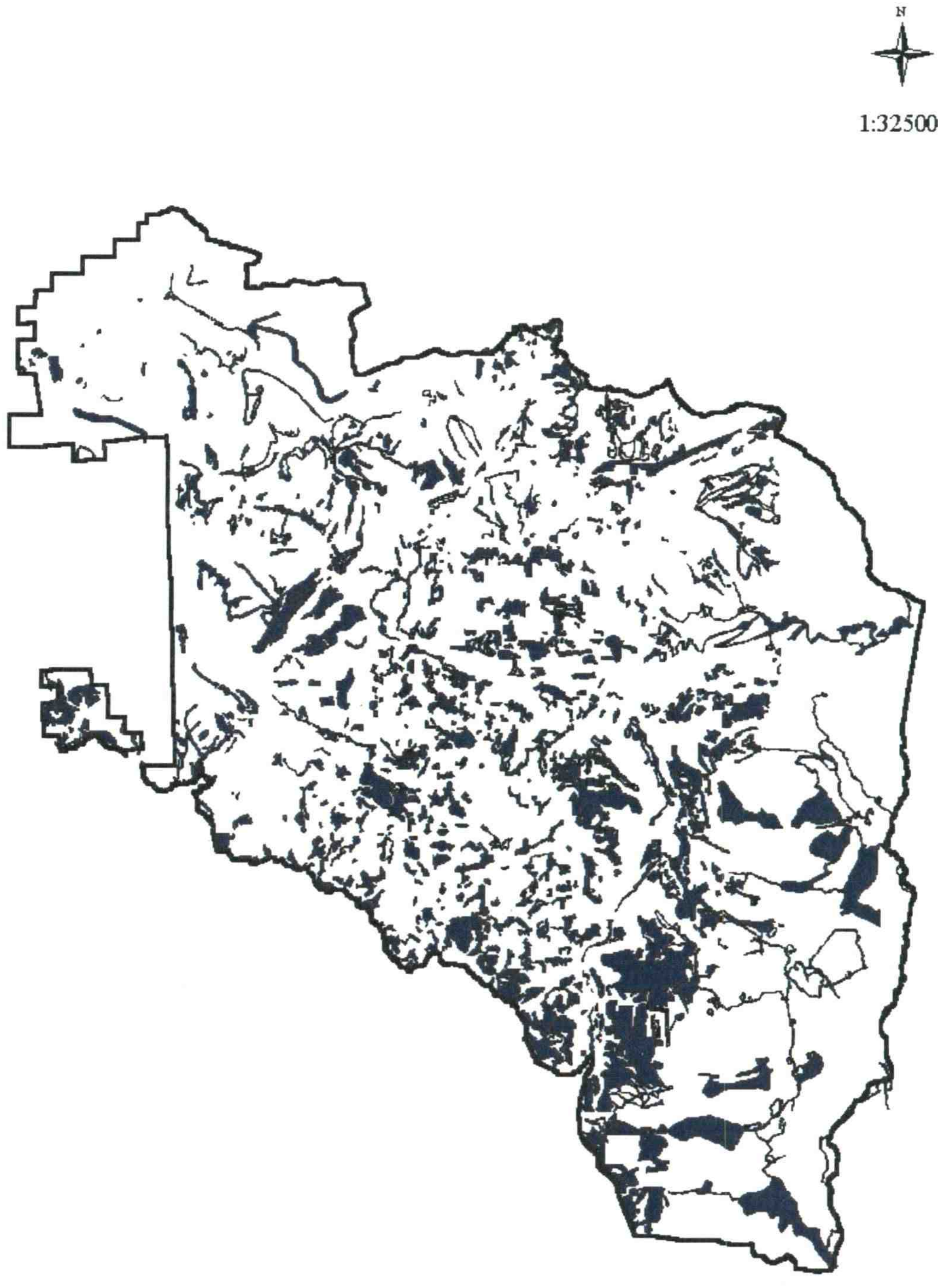
A histogram was created from each reclassified distance grid and the aspect, slope, major vegetation, and elevation grids to compare the number of cell values between classes and the percent of the coverage within the study area. For example, the histogram of slope compares the number of cells for each percent slope increment (0-5, 5-10) within the entire data set. The number of cells within each class was then divided by the total number of cells resulting in a percentage for each class.

The site layer was then overlaid onto each independent variable (distance grids, aspect, slope and elevation). A histogram by zone was created to provide a detailed overview of the relationship between the independent variable grids and the cultural site grid. For example, the major vegetation histogram shows how the Western Hemlock, Pacific Silver fir, and Mountain Hemlock series are distributed among the cultural sites. The distance to meadows histogram within zones of cultural sites displays the number of sites located between 0-100 m, 100-200 m and so forth.

Next a histogram of Meadows within zones of Major Vegetation was created to find out where the meadow communities are distributed between the Three Major Vegetation Zones. This was also done with the huckleberry patches, and then repeated for each using the elevation grid.

The cultural survey coverage was then converted to a grid (Figure 12). The survey covers 2182954 cells in the grid, which represents 17 percent of the study area. There are 359 sites used in this study, four are culturally modified cedar trees, three are rock cairns and the rest are lithic sites. Of the 359 sites, 278 were discovered during a systematic survey following transect lines. The new survey grid was then overlaid with each of the independent variables and a histogram was created to show the amount of survey coverage for each environmental grid. The purpose of using the survey coverage was to determine if more sites were associated with a particular environmental variable because there was a higher percentage of survey coverage for that area than the subbasin as a whole.

Figure 12: Survey Coverage, North Santiam Subbasin.



C.Kelly
2001

A density grid of cultural site points was created to measure the distribution of sites per square mile throughout the North Santiam subbasin. The density function distributes the measured quantity of the site point theme throughout the landscape to produce a continuous surface. Spatial Analyst considers where a site point is in relation to other site points. A continuous surface grid is created displaying concentrated site areas and the distribution of single sites outside of those areas. A density grid was created first using the set of sites (n=359) that were used for all of the above analyses. Then, for comparison, a density grid was created using the 359 site locations and the 445 prehistoric isolated find locations. Single site locations are considered within the 0-1 site density areas. For visual purposes all of the single sites were selected and then overlaid onto the density map. The results of this analysis are presented in the following chapter.

CHAPTER 7
RESULTS

GIS Spatial Analyst Results

The objective of the GIS analysis is to test the three Cascade land-use models to determine if there are any significant associations between site locations and the chosen environmental variables. The results of the GIS analysis and chi-square statistical test are discussed by each independent environmental variable.

Aspect

Solar exposure is considered an important variable in the cool damp environment of the western slopes of the Cascade Range, especially from fall through spring when the sun is lower in the sky and air temperatures are much cooler. In Burtchard's land-use model, the site density pattern did not reveal an association with solar exposure. In the North Santiam subbasin, the southern exposures show more sites than expected, but the discrepancy is not very large. The GIS analysis and chi-square statistical test indicates that sites are randomly distributed across the different solar exposures (Table 10 Figures 13-15). The reason for this lack of association can only be speculated. During the summer months southern exposure may be less desirable due extreme heat, whereas during fall through spring, the southern exposures may be more desirable because of the cooler days. Wind may have also been in a factor. In the North Santiam subbasin, strong east winds during the fall are a common occurrence, so groups may have situated in areas protected from the wind. The more probable explanation is that other variables were more important than solar exposure when choosing a location. For example, some of the sites, situated adjacent to upper elevation lakes or ponds, are located on the side of the water body facing Mount Jefferson. So, there may have been spiritual reasons for locating on a particular aspect.

Table 10: Aspect Chi-Square Test Results and Survey Coverage

Aspect	% of Area	Observed Sites	Expected Sites	Chi-Square	Total Cells	Cells Surveyed	Survey Coverage
Flat	0.016	4	5.072	0.23	180742	29266	0.1619
North	0.073	16	23.141	2.2	817313	127227	0.1557
Northeast	0.074	24	23.458	0.01	839844	136285	0.1623
East	0.132	36	41.844	0.82	1476167	204934	0.1388
Southeast	0.104	42	32.968	2.47	1168053	172901	0.1480
South	0.099	41	31.383	2.95	1117176	190051	0.1701
Southwest	0.145	60	45.965	4.29	1630137	280865	0.1723
West	0.177	53	56.109	0.17	1983549	359182	0.1811
Northwest	0.18	41	57.06	4.52	2009859	375003	0.1866
Total	1	317	317	17.66	11222840	1875714	

Note: Significance fixed at 0.01, 8 degrees of freedom = 20.090

Figure 13: Aspect, North Santiam Subbasin.

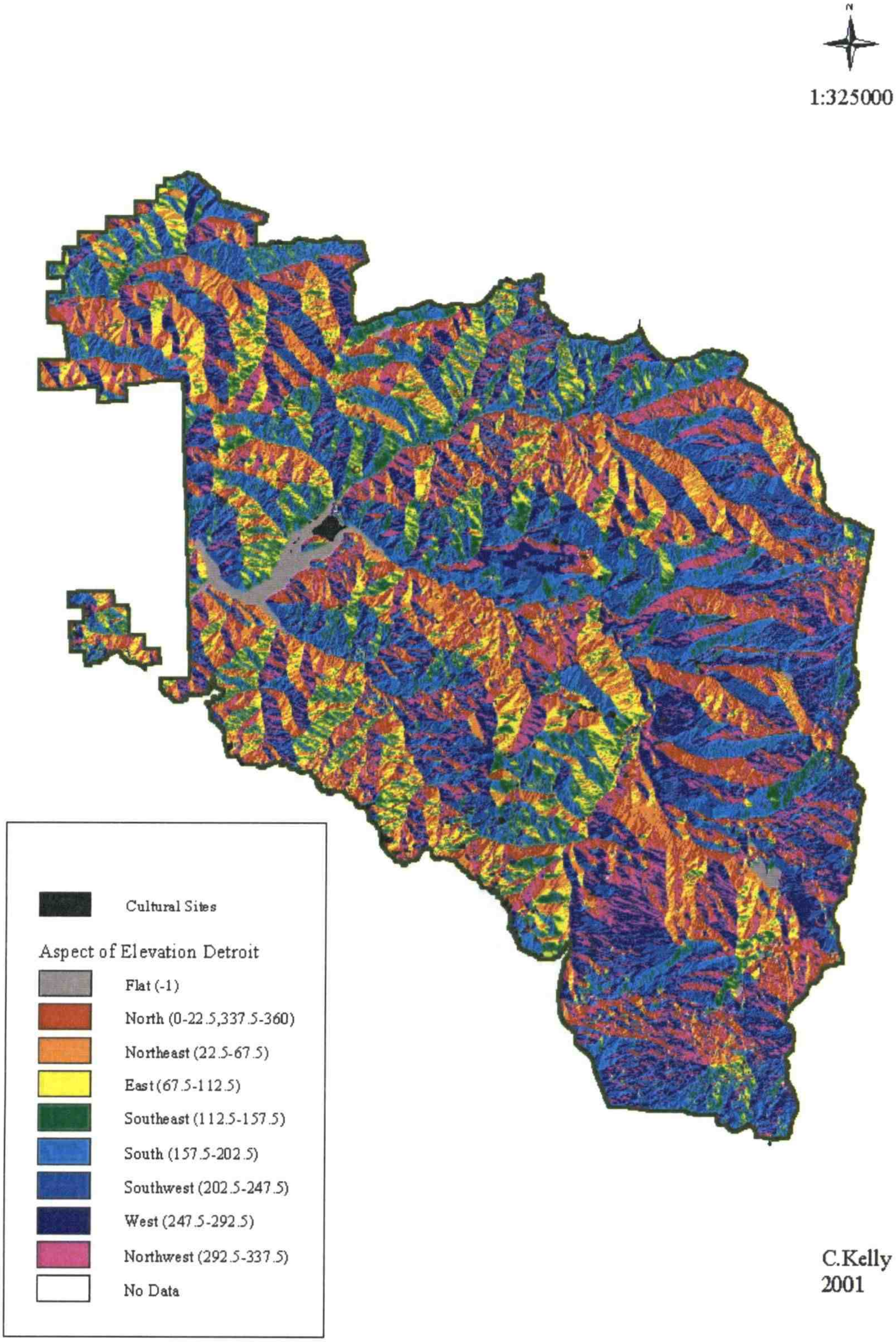
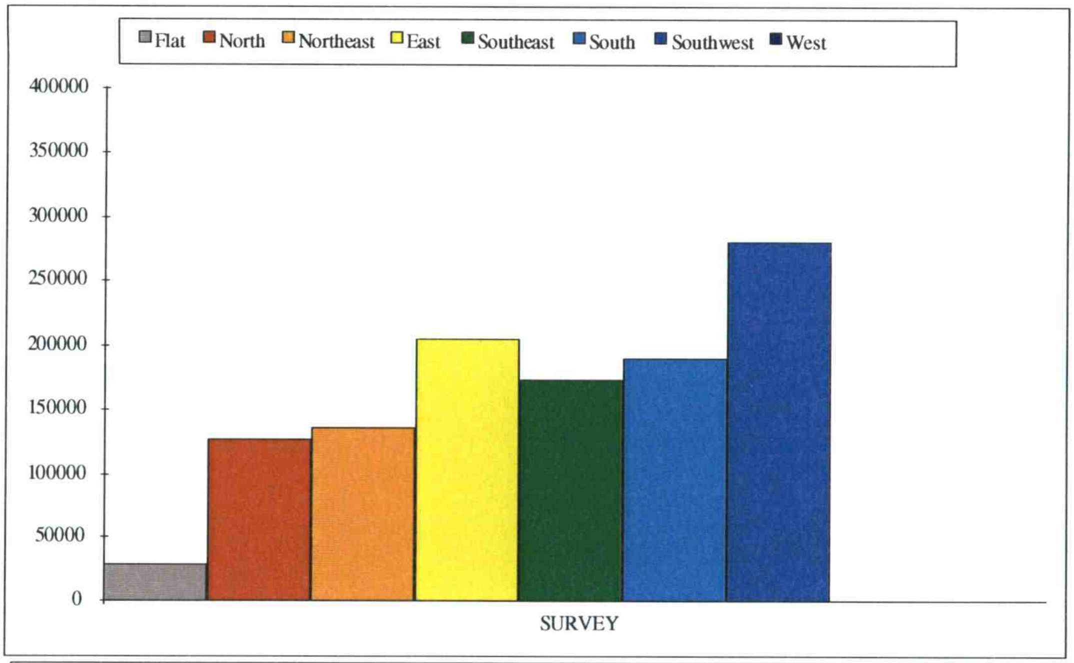


Figure 14: Histogram of Survey and Sites within Zones of Aspect.



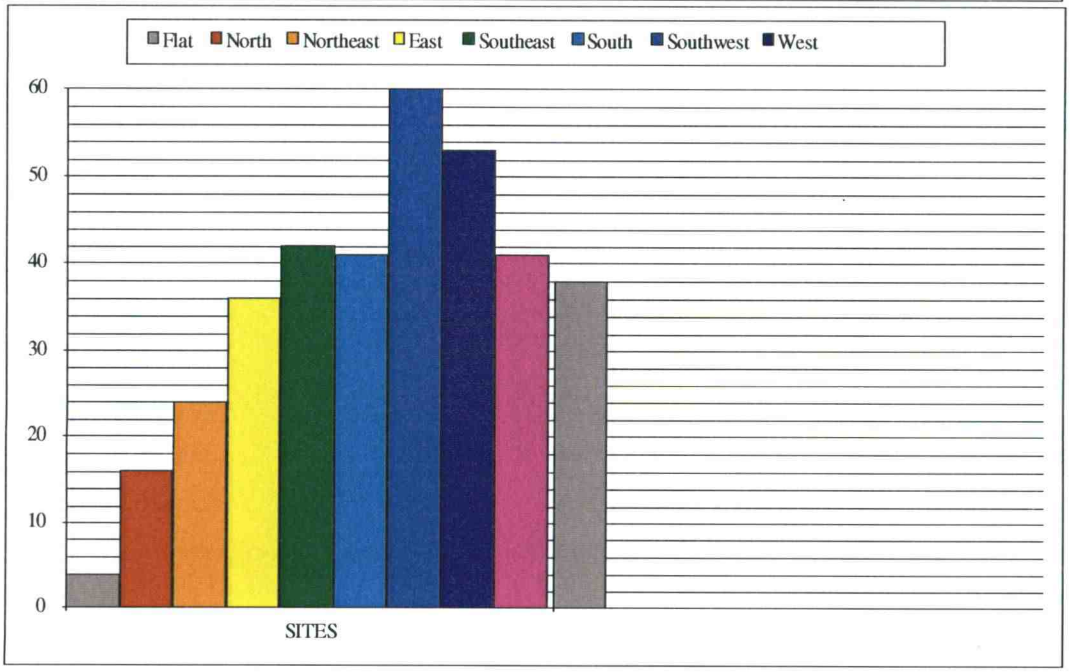
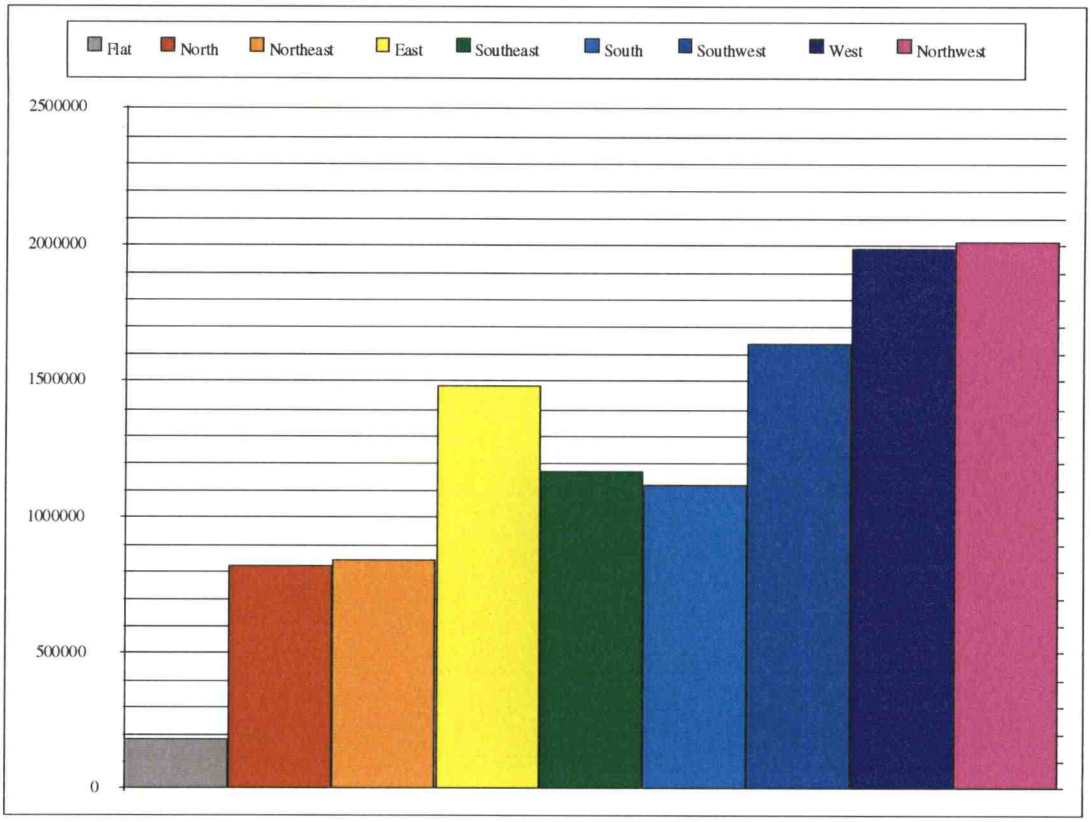


Figure 15: Histogram of Aspect



Percent Slope

Slope is often incorporated into land-use models because site locations are typically located on flat surfaces where steep slopes do not interfere with activities. Burtchard's model shows slope to be a key predictive variable for the presence of site density. In the North Santiam subbasin, the distribution of sites clearly indicates the importance of gently sloping surfaces (Figure 16). Slope ranges in the subbasin from 0 to 150 percent with a mean slope of 35 percent (Figure 17). The results indicate that, as expected, most sites are located on 0 to 25 percent slopes. The percent of surveys is over represented on slopes 25 percent and less, which is expected because the Forest Inventory Plan requires 100 percent survey of these slopes for all ground disturbing projects (Figure 18). Thirty-seven percent of the subbasin is located on 0 to 25 percent slopes, and 29 percent of this ground has been surveyed. A total of 10 percent was surveyed on slopes greater than 25 percent. The result of the chi-square test rejects the null hypothesis of random distribution (Table 11).

Table 11: Percent Slope Chi-Square Test Results and Survey Coverage

Percent Slope	% of Area	Observed Sites	Expected Sites	Chi-Square	Total Cells	Cells Surveyed	Survey Coverage
0-5	5.4	76	19.386	165.33	697748	222128	32.0
5-10	7.3	101	26.207	213.45	939280	351681	37.0
10-15	8.2	63	29.438	38.26	1064081	327238	31.0
15-20	8.3	49	29.797	12.38	1067612	281829	26.0
20-25	7.8	28	28	0	1001823	220052	22.0
25-35	13.7	18	49.150	19.7	1764331	301065	17.1
35-50	18.2	15	65.302	38.72	2344129	263330	11.0
50-75	22.2	8	79.698	64.5	2860968	174092	6.1
75-100	7.4	1	26.566	24.6	950849	34885	3.7
100-125	1.2	0	4.308	4.31	158603	5225	3.3
125-150	.30	0	1.077	1.08	37543	0	0
150-175	0	0	0			0	
>175	0	0	0			0	
Total	1	359	359	582.33	12886967	2181525	

Note: Significance fixed at 0.01, 10 degrees of freedom = 23.209

Figure 16: Percent Slope, North Santiam Subbasin.

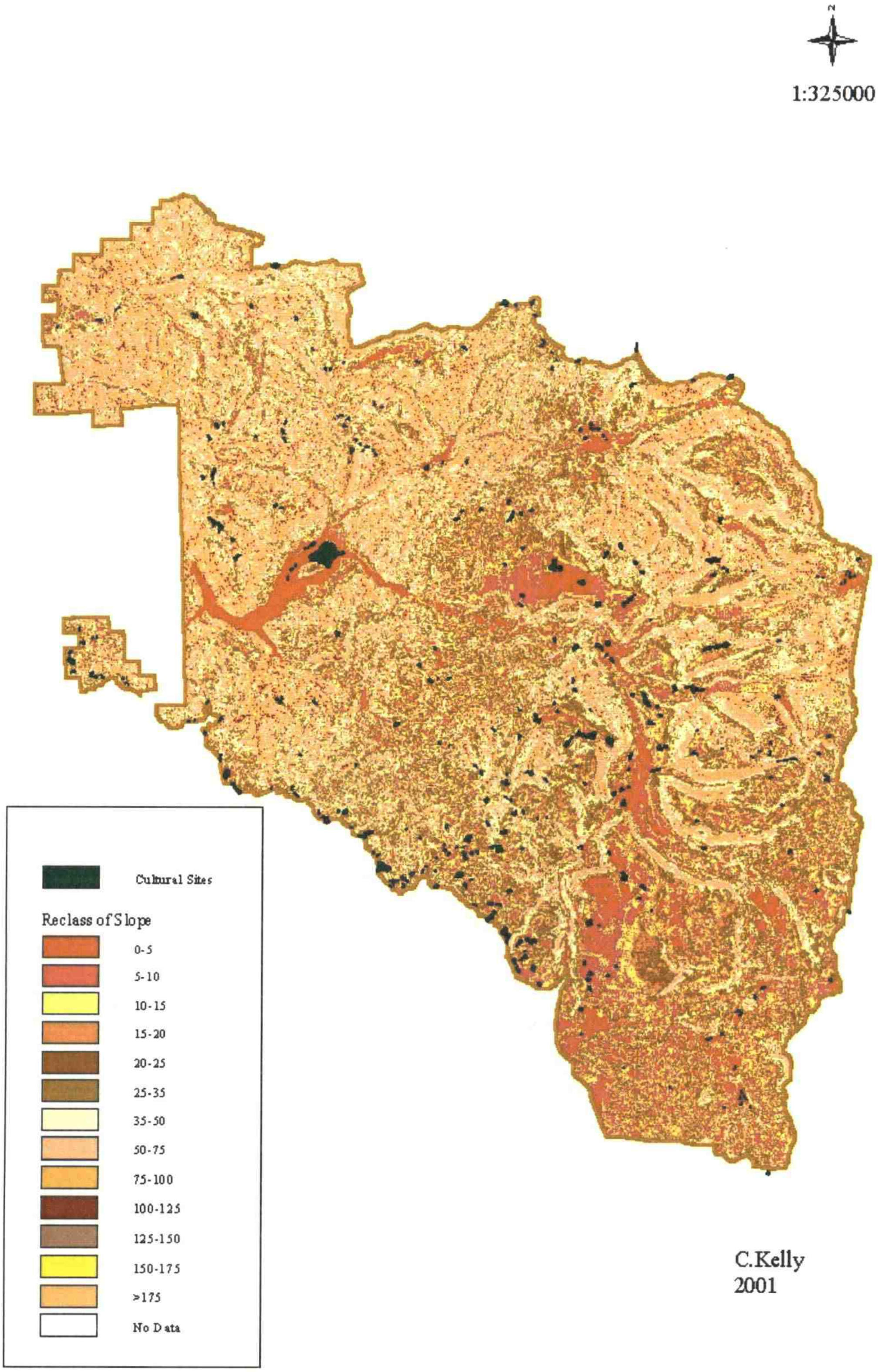


Figure 17: Histogram of Percent Slope.

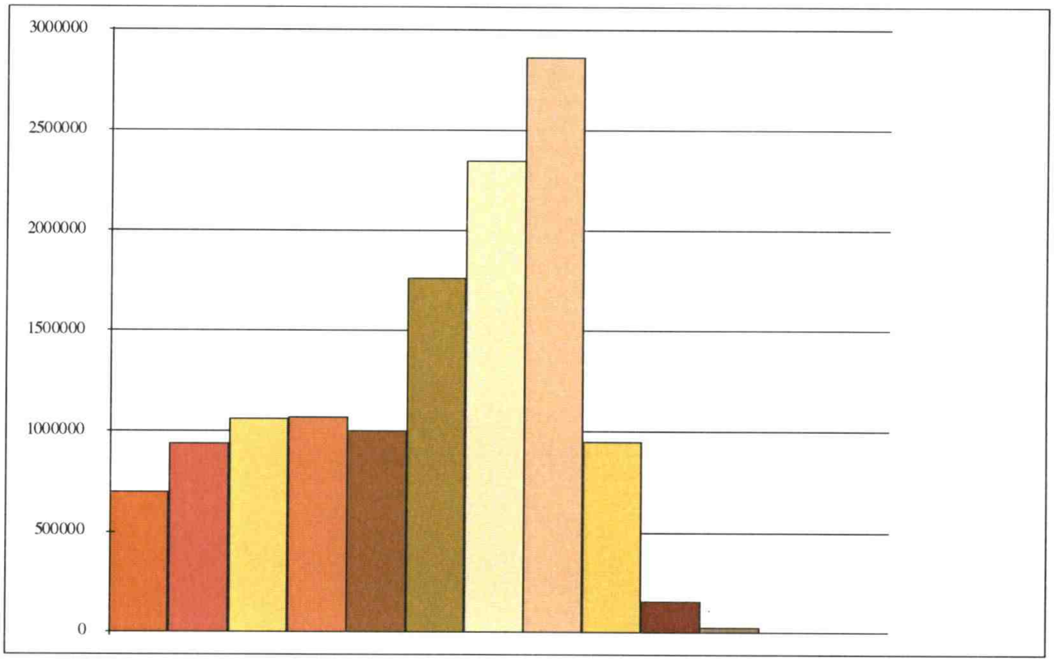
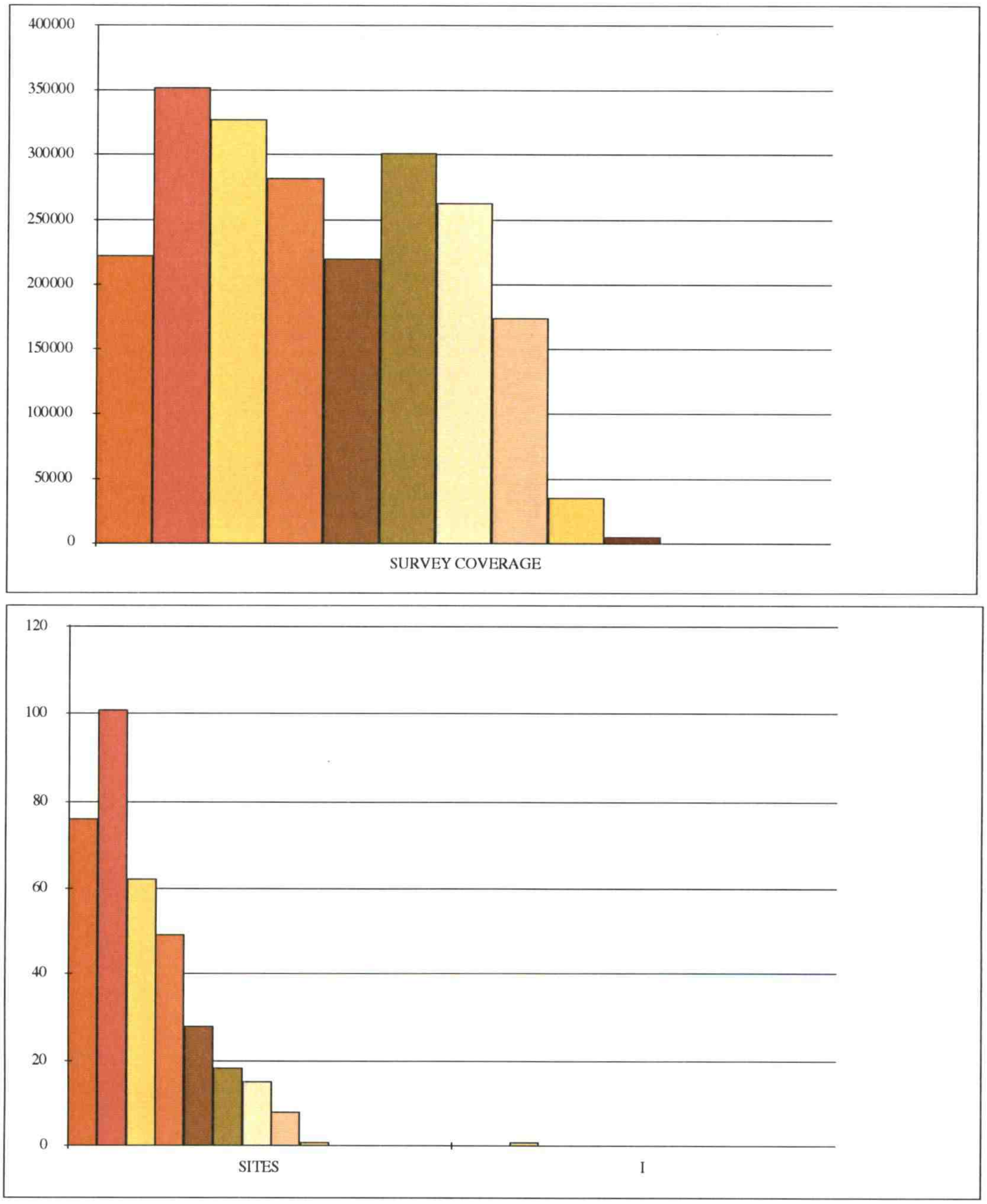


Figure 18: Histogram of Survey and Sites within Zones of Percent Slope.



Vegetation

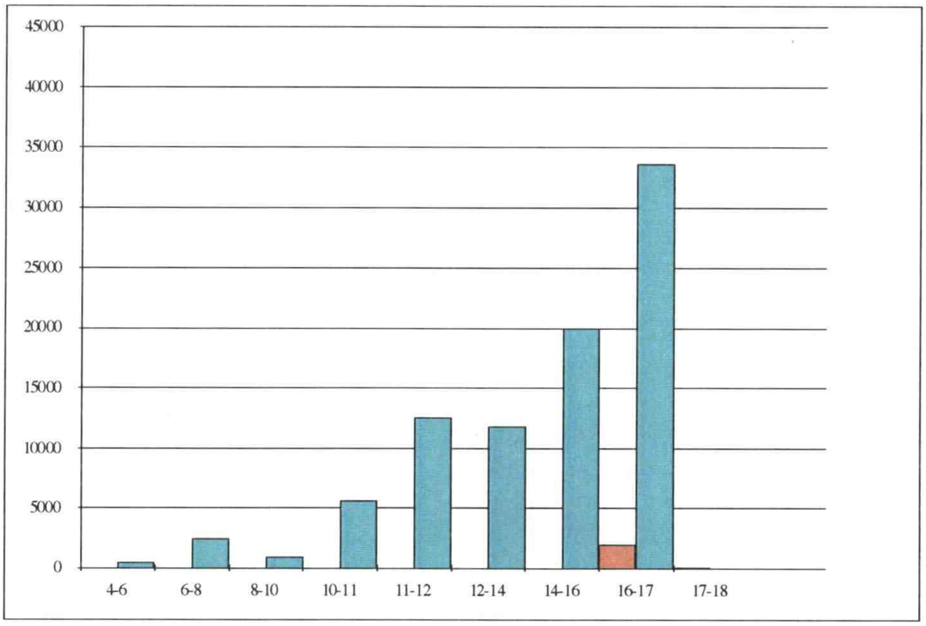
Meadow communities, huckleberry patches, and vegetation series are all important predictive variables for site location in the three land-use models. Meadows and huckleberries are tied to the vegetation series, which are located in three different elevation zones. The results of the GIS analysis and chi-square test are discussed below for these vegetation types.

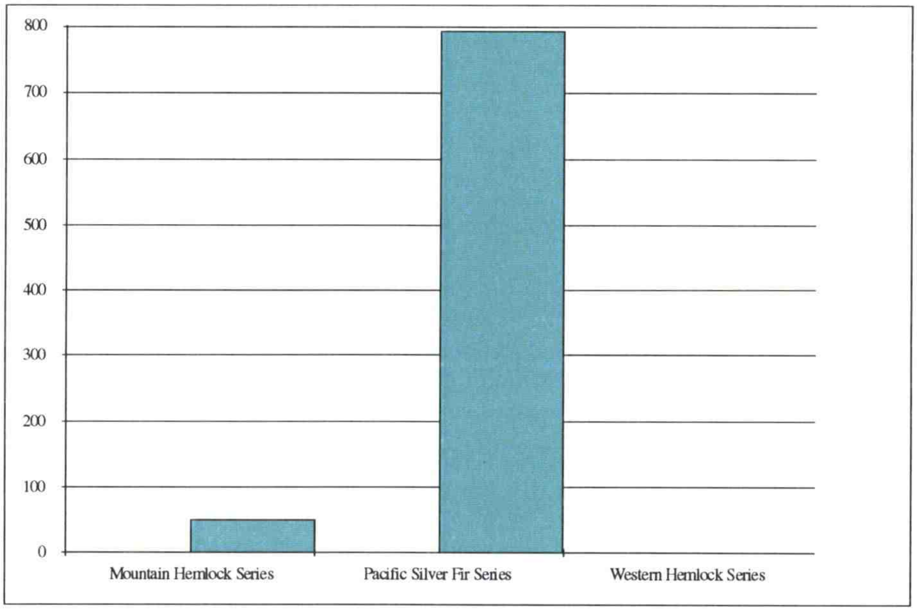
Distance to Meadows

The Cascade land-use models indicate that a high percent of sites should be located near these non-forested environments "...based on their predictable floral and fauna concentrations sought out by humans... (Snyder 1987:60)." Snyder's study shows that in the Upper Middle Fork of the Willamette, the site distribution patterns are significantly associated with wet meadow communities; and sites in close proximity to wet meadows were restricted to elevations above 3500 ft (1067 m).

The meadow communities in the North Santiam subbasin are found in all three vegetation zones and at all elevations (Figure 19). The four meadows types were discussed in Chapter 2 under non-forested communities; the subalpine meadows are included under the discussion of moist meadows.

Figure 19: Histogram of Meadow Communities within Zones of Elevation and Major Vegetation.





The results of the analysis (Table 12; Figures 20 and 21) indicate that 4.3 percent of the subbasin covers a distance less than 100 m from a meadow, and 45 sites (12.5 %) have been recorded at this distance from meadow communities (Figure 22). In other words, meadow communities occupy a very small proportion of the North Santiam subbasin. If the sites were randomly distributed, we would expect to find 15 sites (4 %) at this distance from a meadow. Surveys covered 27 percent of the 0 to 100 m zone around the meadows, which is 10 percent more than the entire subbasin as a whole (Table 12; Figure 22). This is not enough of a discrepancy to explain the large difference between the observed and expected number of sites. Survey coverage was also relatively evenly distributed from 0-500 m from the meadows. At a distance of 0-400 m from a meadow, a total of 118 sites (33 %) have been recorded. This distance covers 16 percent of the subbasin and about 25 percent of this area has been surveyed. The chi-square test rejects the null hypothesis that sites are randomly distributed among meadow communities.

Broken down by meadow type, the data show that prehistoric groups are not choosing a particular meadow type more often. Most of the meadows on the district are wet or moist and are concentrated at the 1000 to 2000 m elevation range. Some dry meadows occur between 1400 and 1800 m in elevation, and subalpine meadows are found above 1500 m. A total of 65 sites have been recorded within the 0 to 400 m distance from a wet meadow, and within the same distance interval to a moist, subalpine, and dry meadow, a total of twenty-seven, fourteen, and thirteen sites respectively have been located.

Table 12: Distance to Meadows Chi-Square Test Results and Survey Coverage.

Meadows Distance in Meters	% of Area	Observed Sites	Expected Sites	Chi-Square	Total Cells	Cells Surveyed	Survey Coverage
0-100	0.043	45	15.437	56.62	549972	147226	0.26770
100-200	0.037	24	13.283	8.65	478321	121757	0.25455
200-300	0.042	22	15.078	3.18	539235	129145	0.23950
300-400	0.044	27	15.796	7.95	570992	128480	0.22501
400-500	0.046	20	16.514	0.74	578343	120788	0.20885
500-600	0.046	14	16.514	0.38	586883	114218	0.19467
600-700	0.045	24	16.155	3.81	585234	106166	0.18141
700-800	0.044	13	15.796	0.49	567670	94960	0.16728
800-900	0.043	17	15.437	0.16	556995	89978	0.16154
900-1000	0.041	10	14.719	1.51	532291	88545	0.16635
1000-1500	0.175	61	62.825	0.05	2252931	384787	0.17073
>1500	0.394	82	141.446	24.98	5082718	656904	0.12924
Total	1	359	359	108.52	12881585	2182954	

Note: Significance fixed at 0.01, 11 degrees of freedom = 24.725

Figure 20: Distance to Meadows, North Santiam Subbasin.

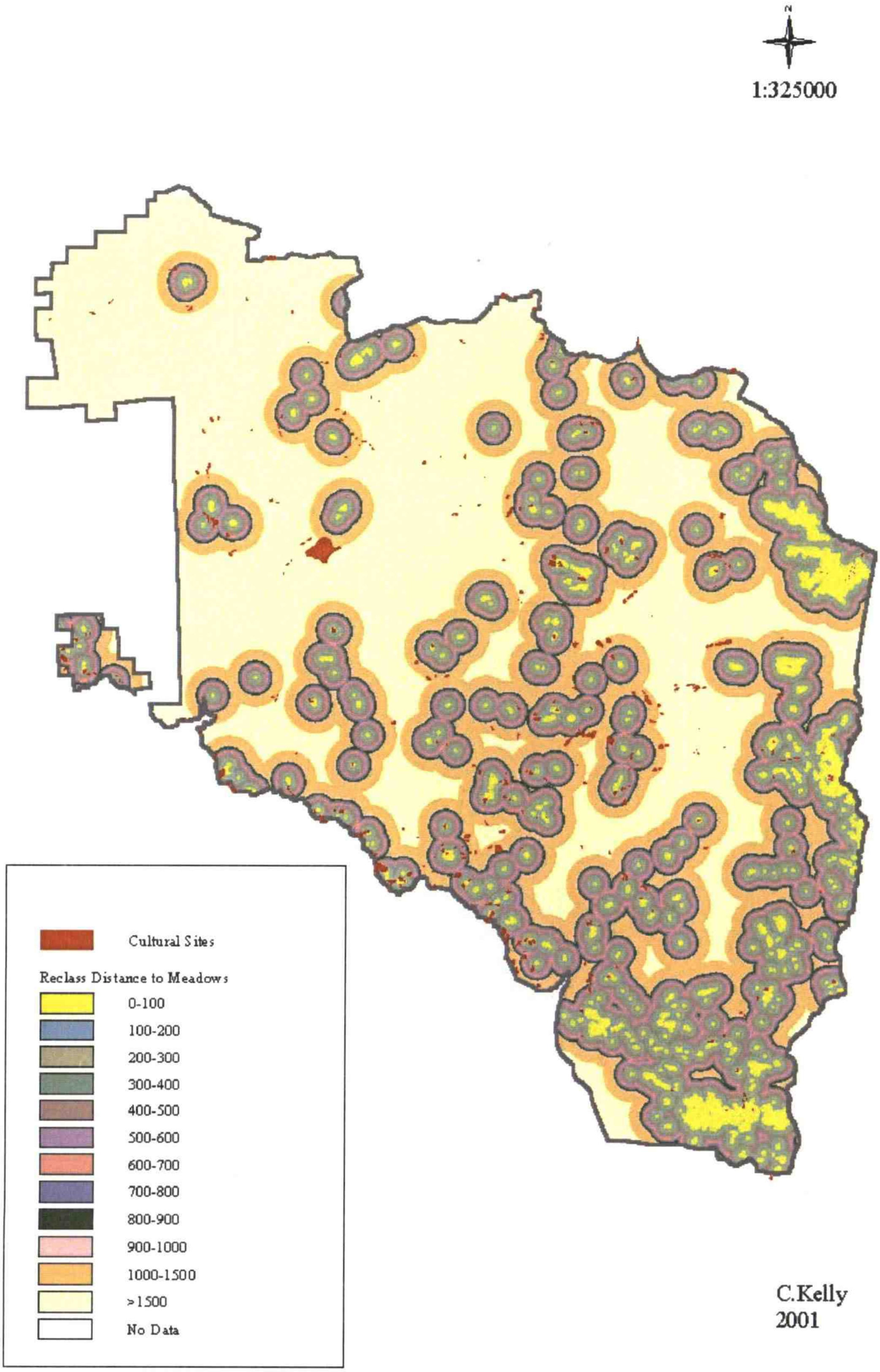


Figure 21: Histogram of Distance to Meadows.

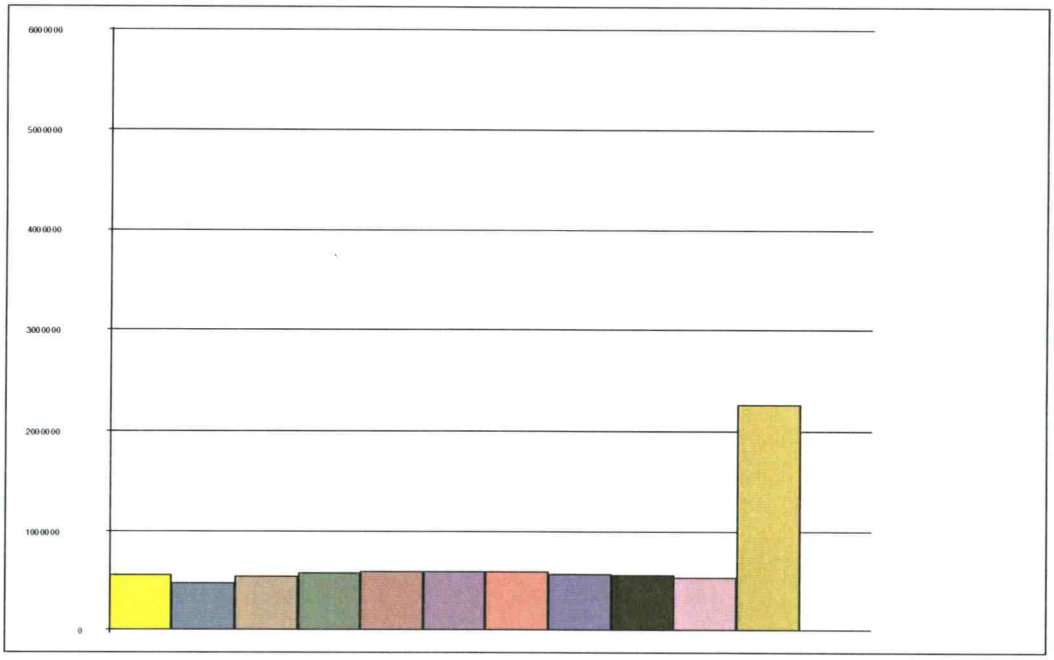
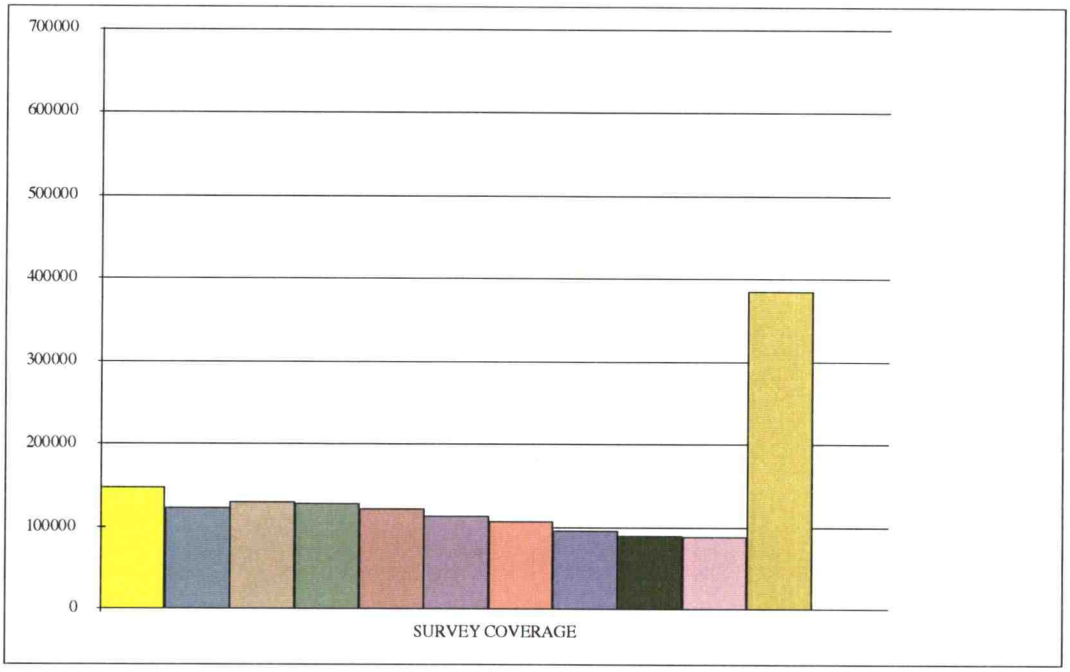


Figure 22: Histogram of Survey and Sites within Zones of Distance to Meadows.



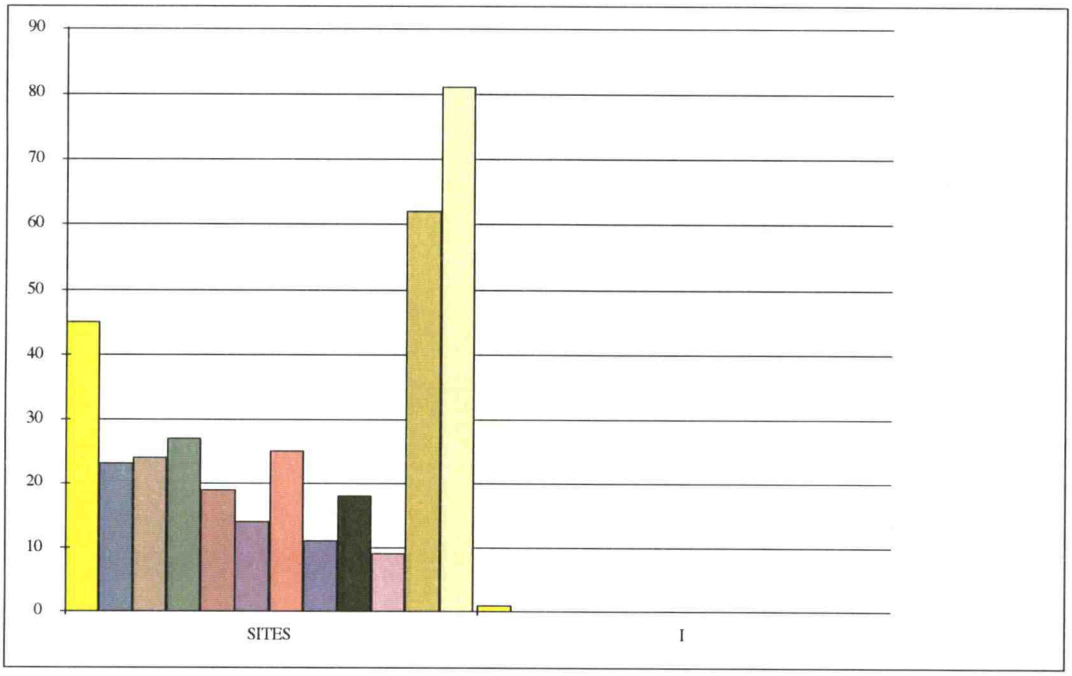
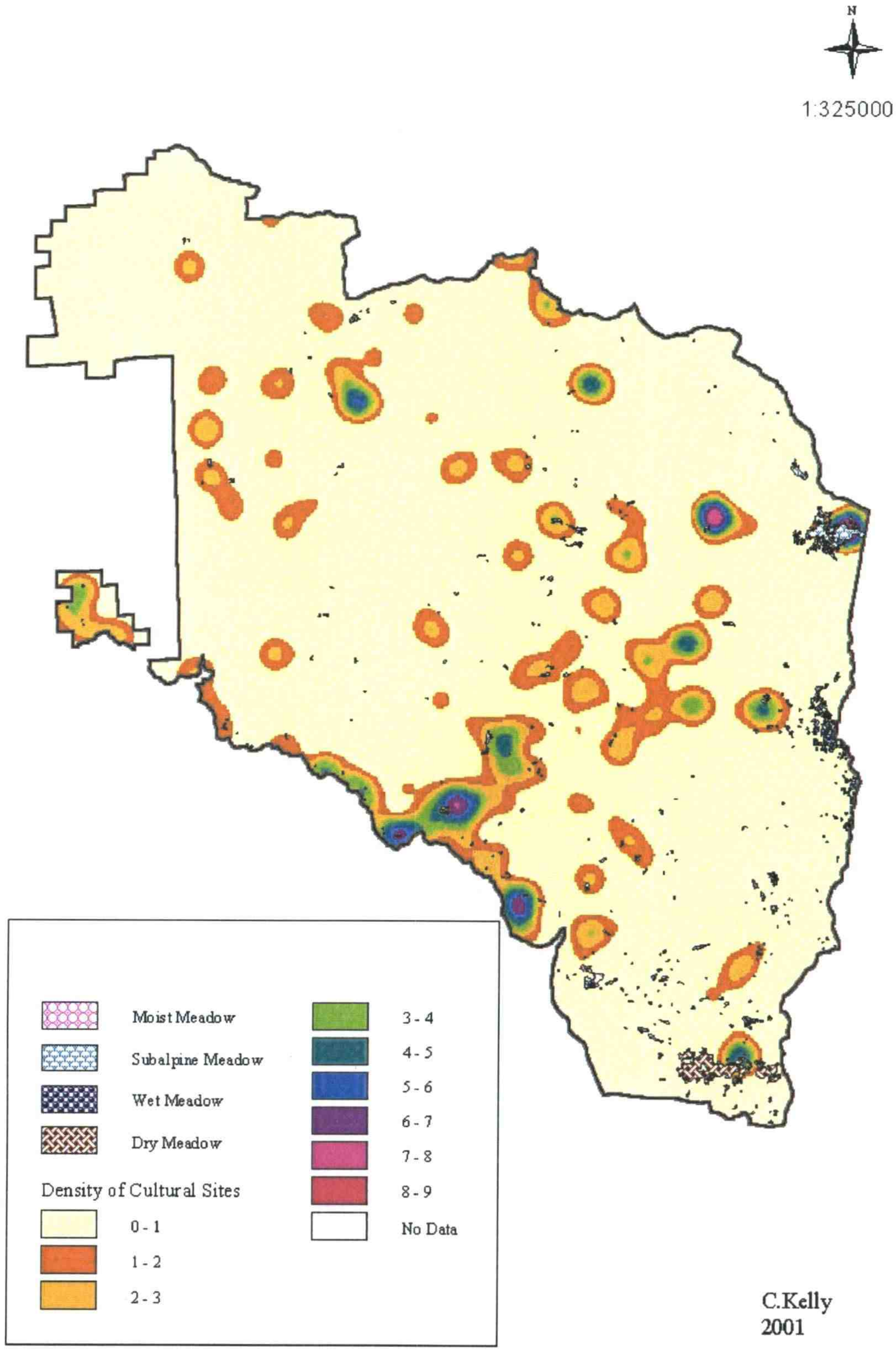


Figure 23 shows the density of sites in relation to the meadow types. The largest cluster of subalpine associated sites is found in Jefferson Park at the foothills of Mount Jefferson. These subalpine meadows are associated with numerous glacial ponds and lakes, and Cascade huckleberry patches. The density of sites associated with a wet meadow ranges from one to six, for a moist meadow there is a density of one to four sites, and for a dry meadow the density of sites ranges from two to six. Most of the meadows except for the subalpine have two or three sites near a meadow. This conforms to Snyder's land-use model, which predicts that sites are significantly associated with wet, moist and dry meadows above the 1067 m (3500 ft) in elevation.

Figure 23: Density of Sites within Zones of Meadow Communities, North Santiam Subbasin.



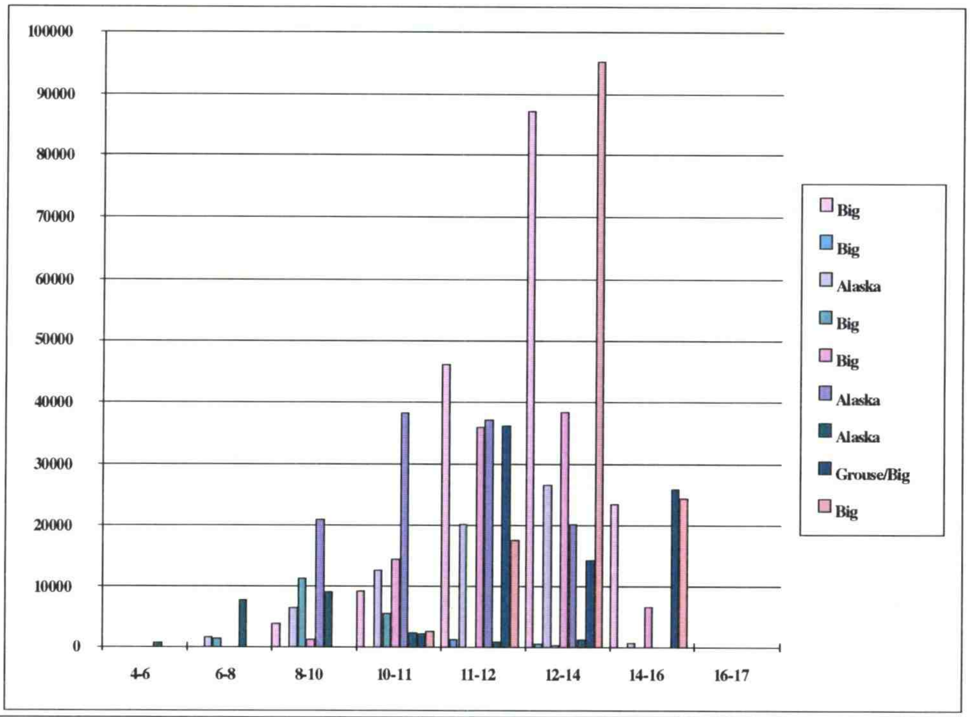
Distance to Huckleberry Patches

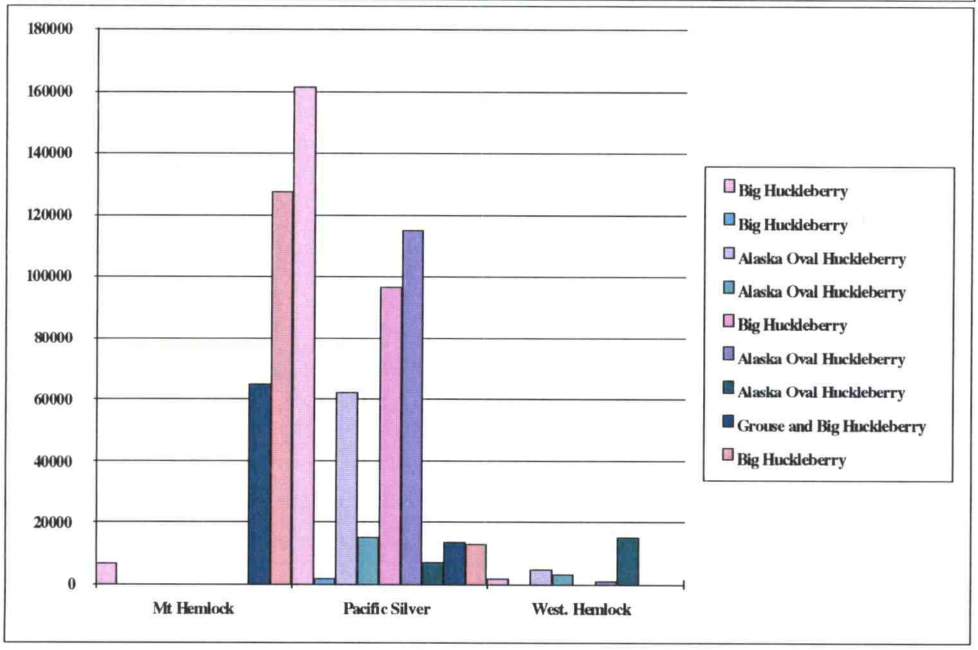
Baxter's land-use model suggests that upland sites are only associated with hunting and berry picking above 1067 m (3500 ft) in elevation. He argues that sites above 3500 ft were located no more than two linear miles from a lowland site, and that these upland sites were not occupied as summer base camps, but instead revisited again and again by hunting and berry picking expeditions.

Five types of huckleberries (Big huckleberry, Cascade or Dwarf Blue huckleberry, Grouse huckleberry, and Alaska and Oval leaf huckleberries) grow in the North Santiam subbasin. Figure 24 shows that huckleberries are located between 400 and 1700 m in elevation. The three most flavorful are the Big, Cascade, and the tiny Grouse huckleberries. These are located primarily between 1100 and 1600 m in elevation. The Alaska and Oval leaf huckleberries are concentrated between 800 to 1400 m in elevation.

Most of the huckleberry patches grow within the Pacific Silver fir zone (Figure 24). Thirty-eight percent of the Big huckleberries, 28 percent of the Alaska and nine percent of the grouse huckleberries grow within this vegetation zone. Nineteen percent of the Big and two percent of the Grouse huckleberries grow within the Mountain hemlock zone. About four percent of the huckleberries grow within the lower elevation western hemlock zone.

Figure 24: Histogram of Huckleberry Patches within Zones of Elevation and Major Vegetation.





The result of the GIS analysis confirms the importance of these huckleberry patches to prehistoric groups. Table 13 indicates that 24 percent of the district covers ground within 0 to 400 meters of a huckleberry patch. At this distance, a total of 141 sites (39 %) have been recorded (Figures 25 and 26). If the sites were randomly distributed we would expect to find 85 sites (24 %) within 0 to 400 meters of a huckleberry patch. The survey coverage subbasin wide is 17 percent, while survey coverage within 400 meters of huckleberry patch is 25 percent (Table 13; Figure 27). This is not a large enough difference to account for the fact that 60 percent more sites were observed than expected. The chi-square test rejects the null hypothesis of random site distribution.

Table 13: Distance to Huckleberry Patches Chi-Square Test Results and Survey Coverage.

Huckleberry Patches	% of area	Observed Sites	Expected Sites	Chi-Square	Total Cells	Cells Surveyed	Survey Coverage
0-100	0.105	71	37.695	29.51	1351224	430084	0.3183
100-200	0.046	33	16.514	16.46	594444	131834	0.2218
200-300	0.043	21	15.437	2	559843	103752	0.1853
300-400	0.041	16	14.719	0.11	523943	87351	0.1667
400-500	0.039	15	14.001	0.07	487400	73082	0.1499
500-600	0.036	11	12.924	0.29	462906	69869	0.1509
600-700	0.034	18	12.206	2.75	439227	67968	0.1547
700-800	0.032	9	11.488	0.54	417497	65409	0.1567
800-900	0.03	7	10.77	1.32	398066	58652	0.1473
900-1000	0.029	13	10.411	0.64	378148	56181	0.1486
1000-1500	0.13	28	46.67	7.47	1678010	231229	0.1378
>1500	0.435	117	156.165	9.82	5596259	807538	0.1443
Total	1	359	359	70.98	12886967	2182949	

Note: Significance fixed at 0.01, 11 degrees of freedom = 24.725

The density of sites in the vicinity of huckleberry patches ranges from one to eight, with a density of two to four sites most common (Figure 28). The site clusters are associated most often with the Big huckleberry patches.

Figure 25: Distance to Huckleberry Patches, North Santiam Subbasin.

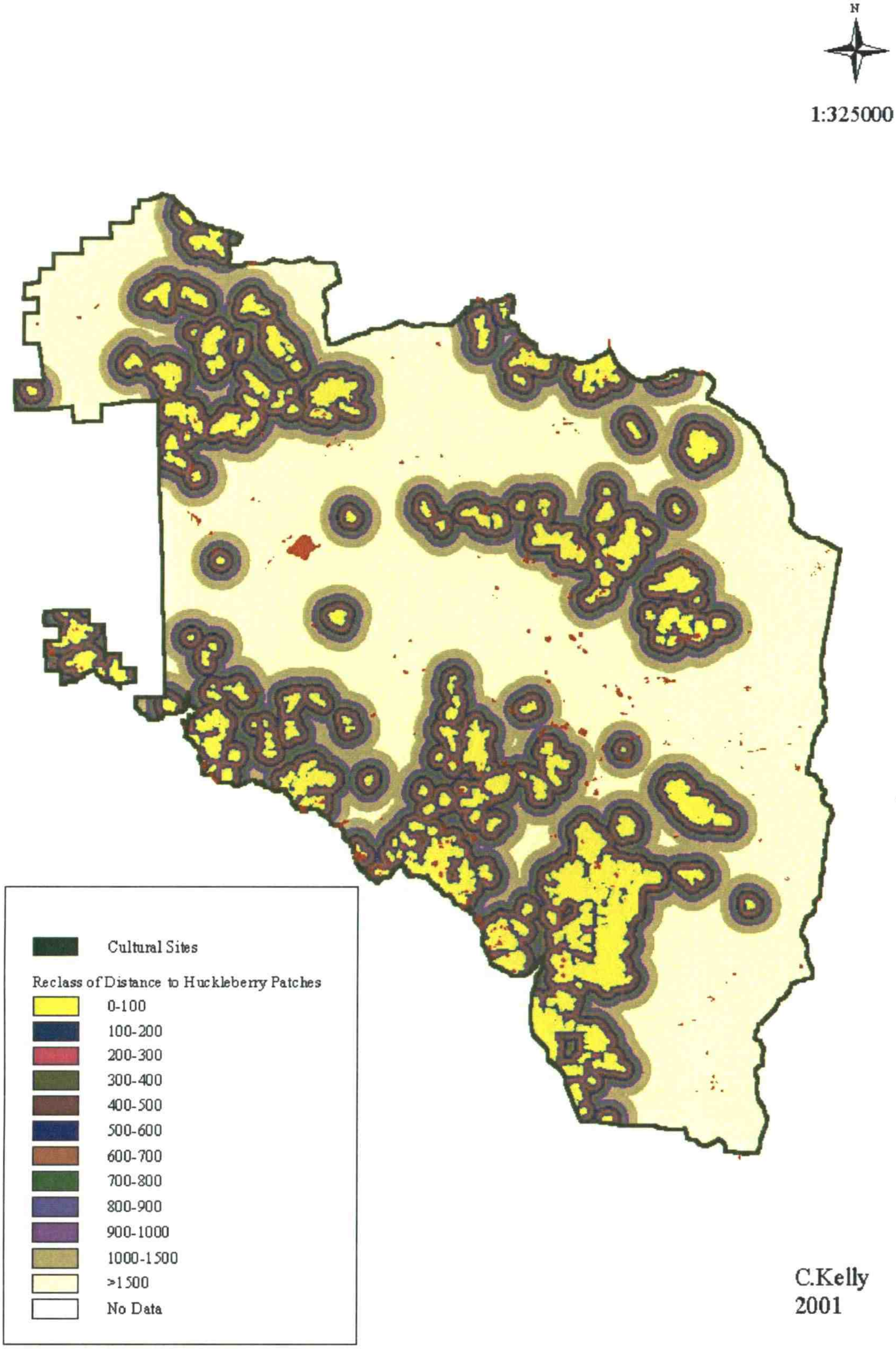
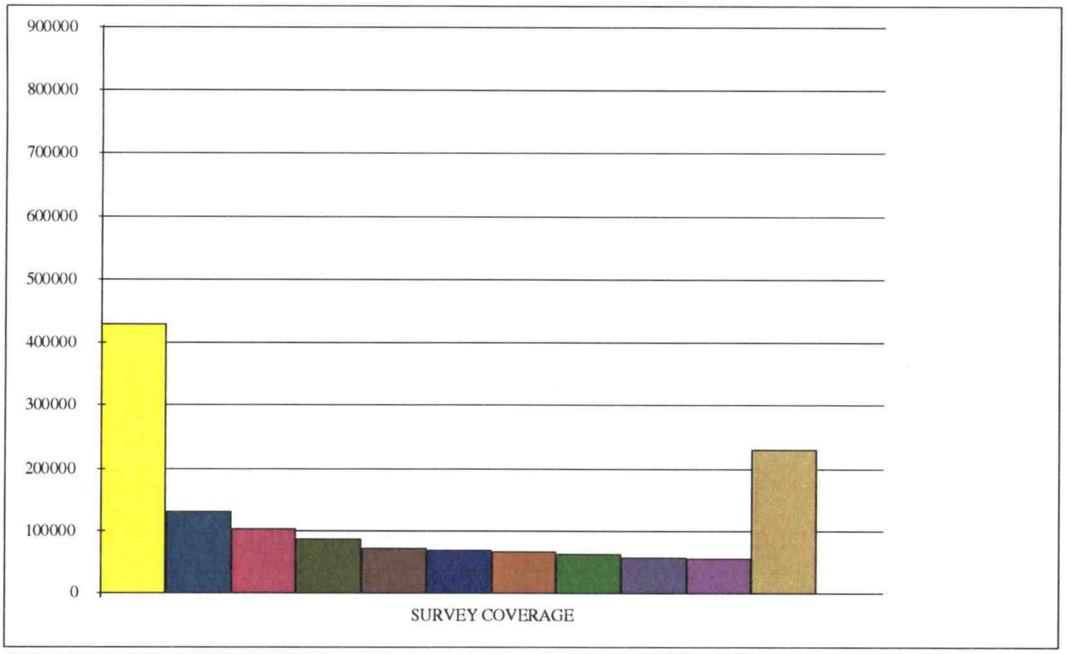


Figure 26: Histogram of Survey and Sites within Zones of Distance to Huckleberry Patches.



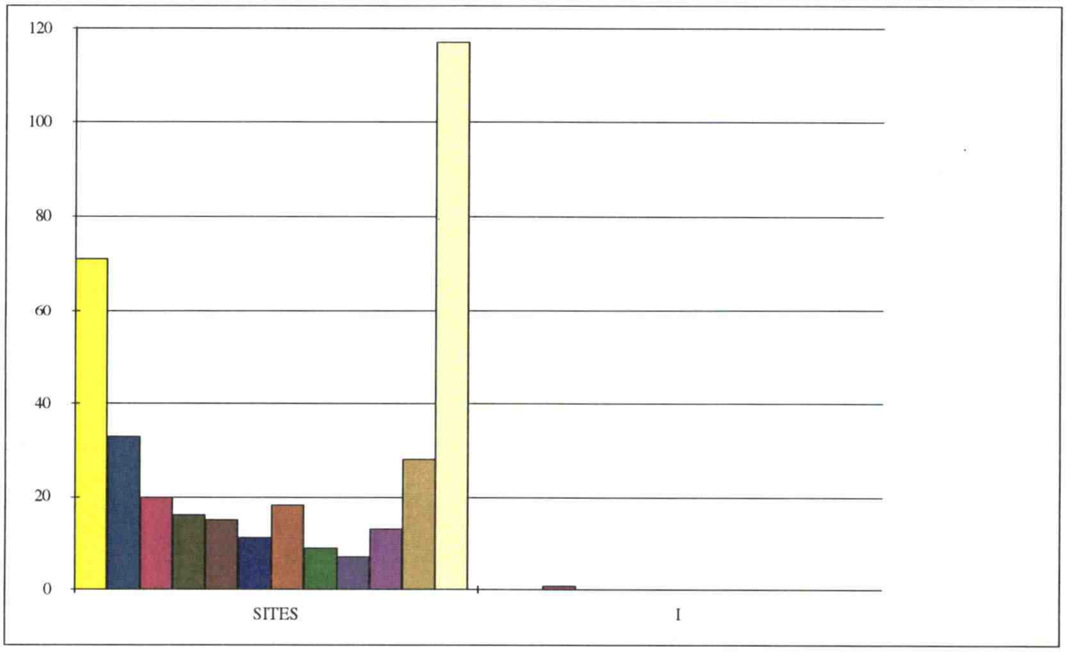


Figure 27: Histogram of Distance to Huckleberry Patches.

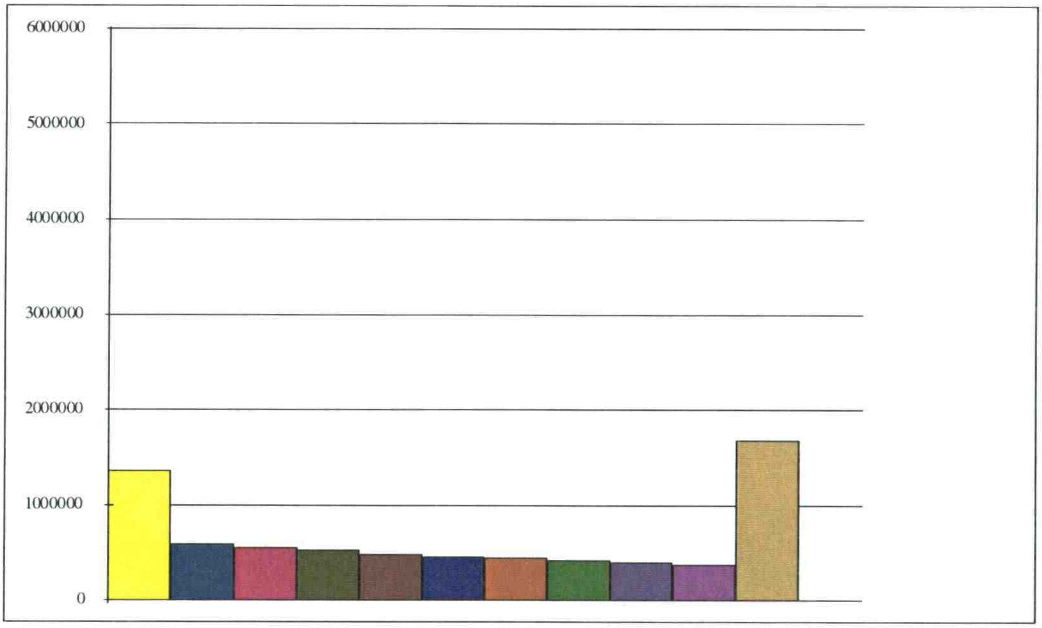
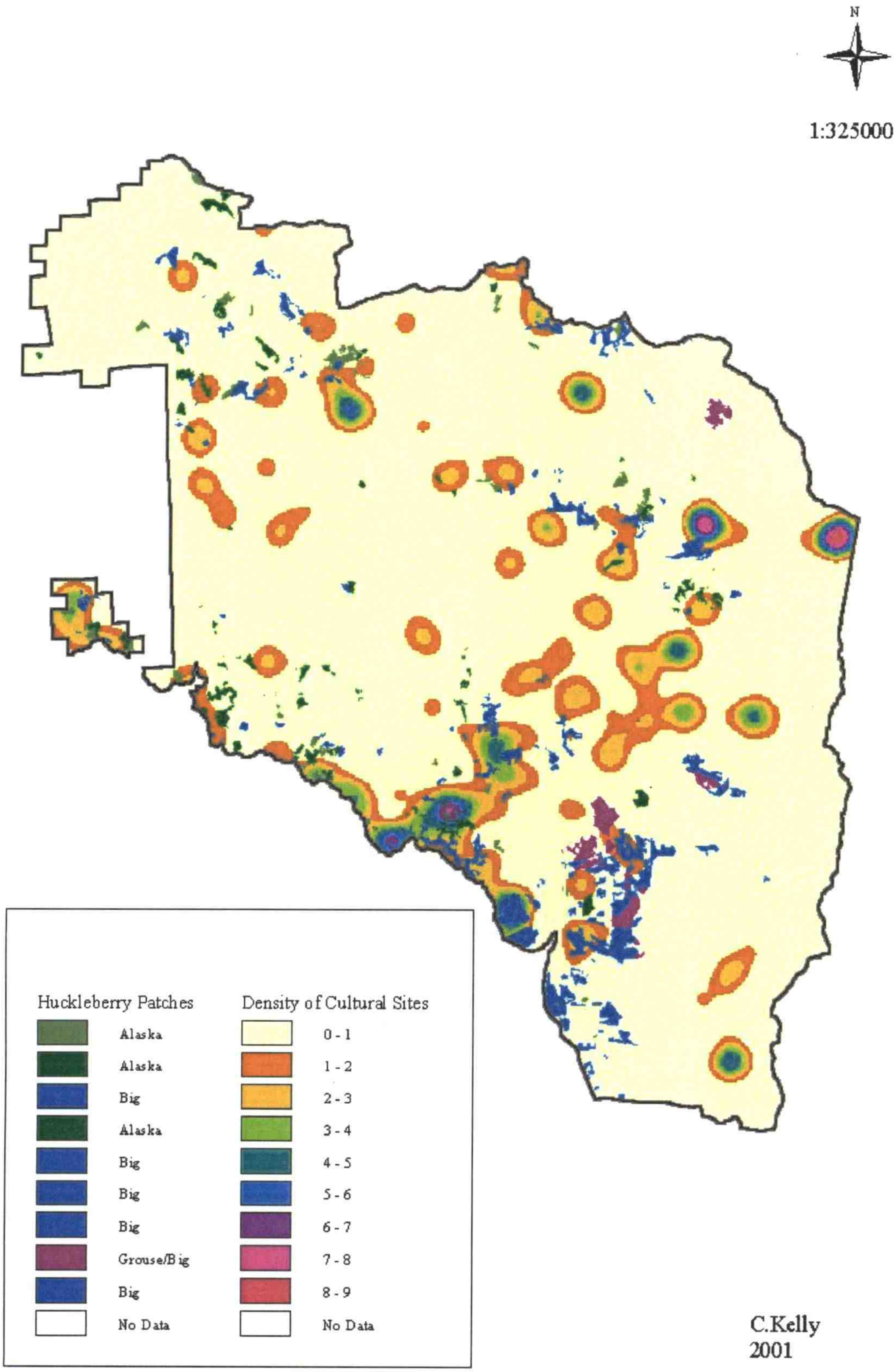


Figure 28: Density of Sites within Zones of Huckleberry Patches, North Santiam Subbasin.



Major Vegetation

Snyder's land-use model indicates a significant association of sites with the high elevation Mountain hemlock and fir zones. The major vegetation zones described in Chapter Two consist of the Mountain hemlock, Pacific Silver fir and Western hemlock. These zones are tied to the annual precipitation and temperature patterns associated with the different elevation gradients. Sites in the subbasin are clearly associated with the Pacific Silver fir zone (Table 14; Figures 29 and 31). The results show that the Pacific Silver fir zone covers 46 percent of the district (Table 14; Figure 30). Within this vegetation zone 198 sites (55 %) are recorded. If the sites were randomly distributed, we would expect to find 144 sites (40 %).

Within the North Santiam subbasin, the Pacific Silver fir zone is located between 800 and 2000 m in elevation but dominates the 900 to 1500 m elevation range. There are almost four times as many sites found in this vegetation zone than then the other two zones. The reason for the high number of sites is that the greatest density of huckleberries and meadow communities most often occur within this zone. Correspondingly, human use of these plant communities is high based on the associated number of sites. There are a relatively even number of sites found within the Mountain and Western hemlock zones. Many of the sites in the western hemlock zone are located either in the lower elevations or within the transition zone (discussed under elevation) located near the edge of the Pacific Silver fir zone. The Mountain hemlock zone covers only 20 percent of the district, and 56 sites (15 %) have been recorded. Most of these high elevation sites are associated with glacial lakes and ponds, and subalpine meadows.

Table 14: Major Vegetation Zones Chi-Square Test Results and Survey Coverage.

Major Vegetation	% of Area	Observed Sites	Expecte d Sites	Chi-Square	Total Cells	Cells Survey	Survey Coverage
Mtn. Hemlock	0.197	56	62.055	0.59	2260217	463117	0.229
Pacific Silver Fir	0.457	198	143.955	20.29	5242427	918580	0.455
Western Hemlock	0.346	61	108.99	21.13	3975728	635167	0.315
Total	1	315	315	42.01	11478372	2016864	

Note: Significance fixed at 0.01, 2 degrees of freedom = 9.21

Figure 32 shows the density of sites in relation to the vegetation zones. Most of the high-density site areas are located with the Pacific Silver fir zone, associated with meadows, huckleberries and lithic material sources. The high-density areas in the Mountain hemlock zone are fewer, and are associated with glacial lakes, ponds, subalpine meadows and huckleberry patches. Within the Western hemlock zone, the one high-density site area is associated with the hot springs along the Breitenbush River.

Figure 29: Major Vegetation Series, North Santiam Subbasin.

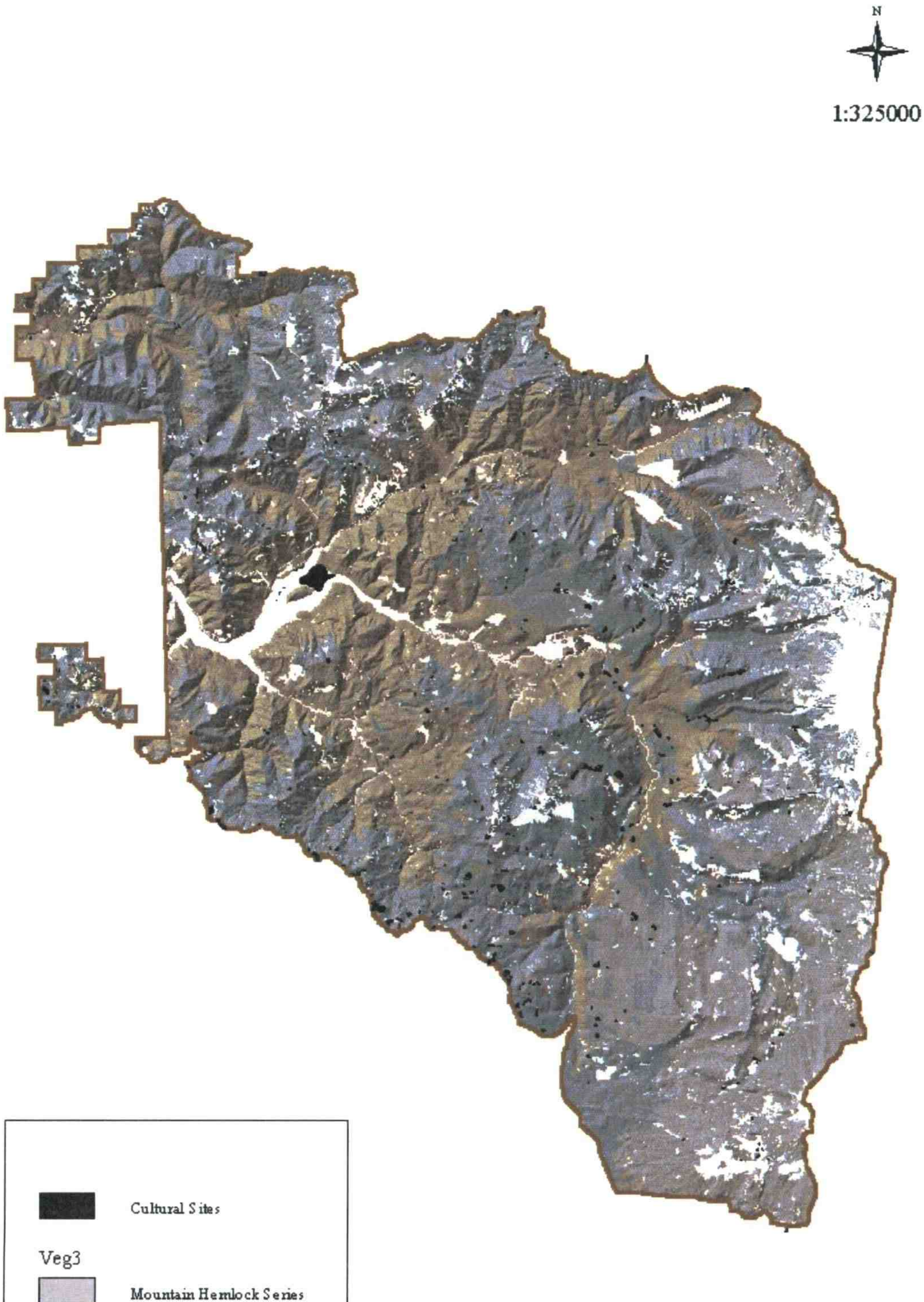


Figure 30: Histogram of Major Vegetation.

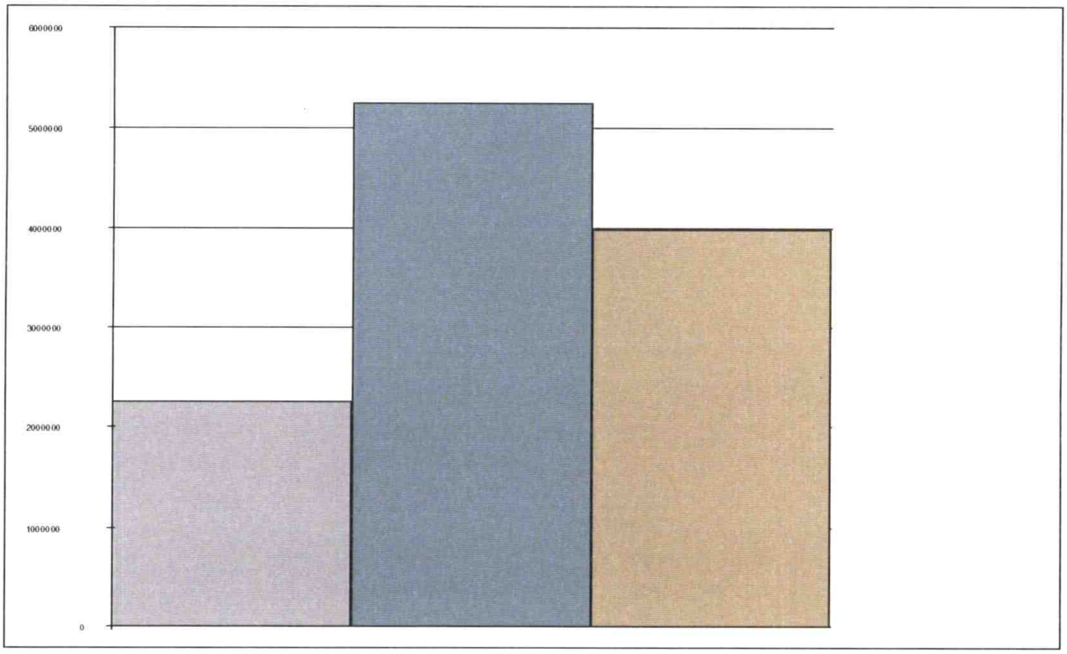


Figure 31: Histogram of Survey and Sites within Zones of Major Vegetation.

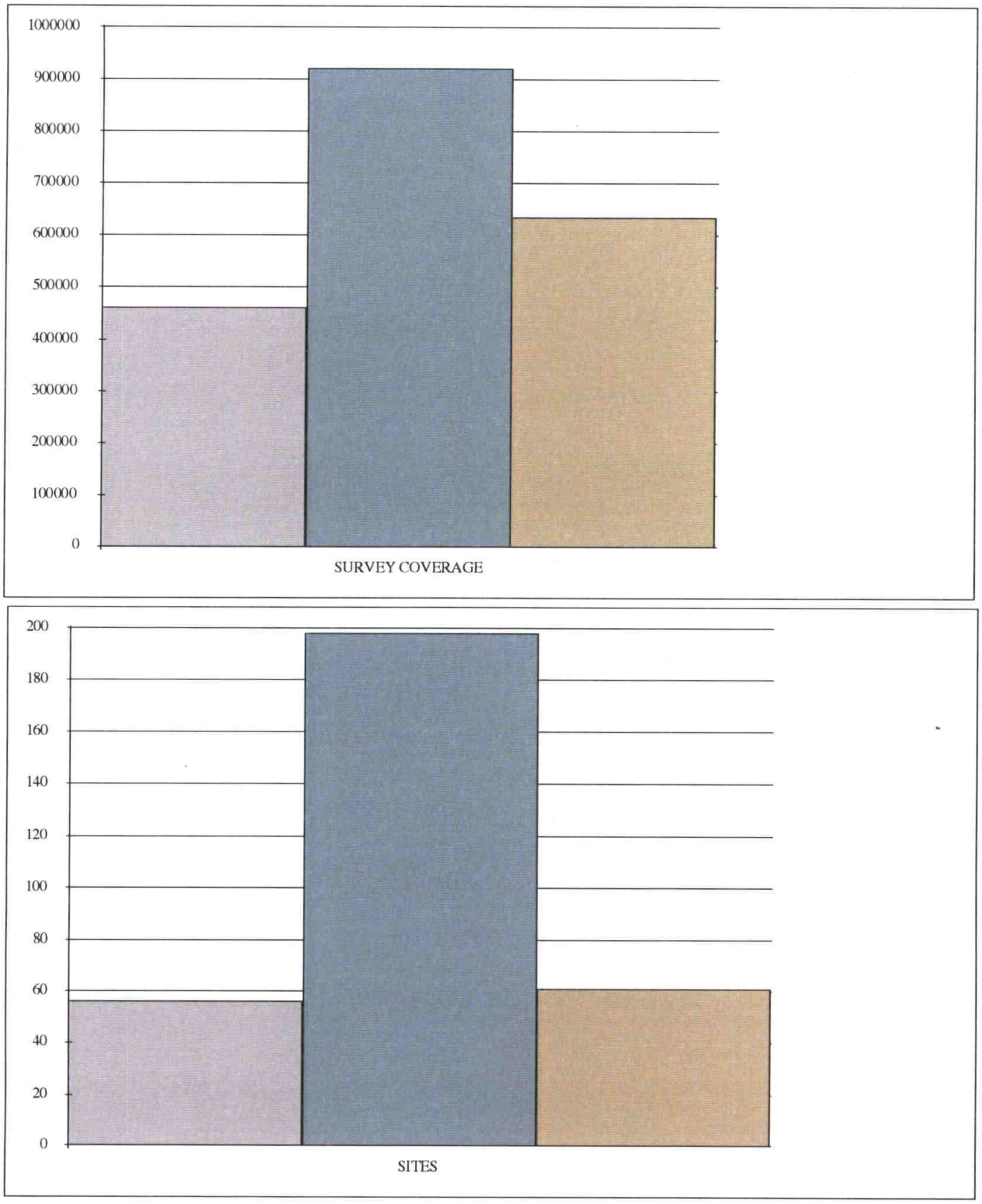
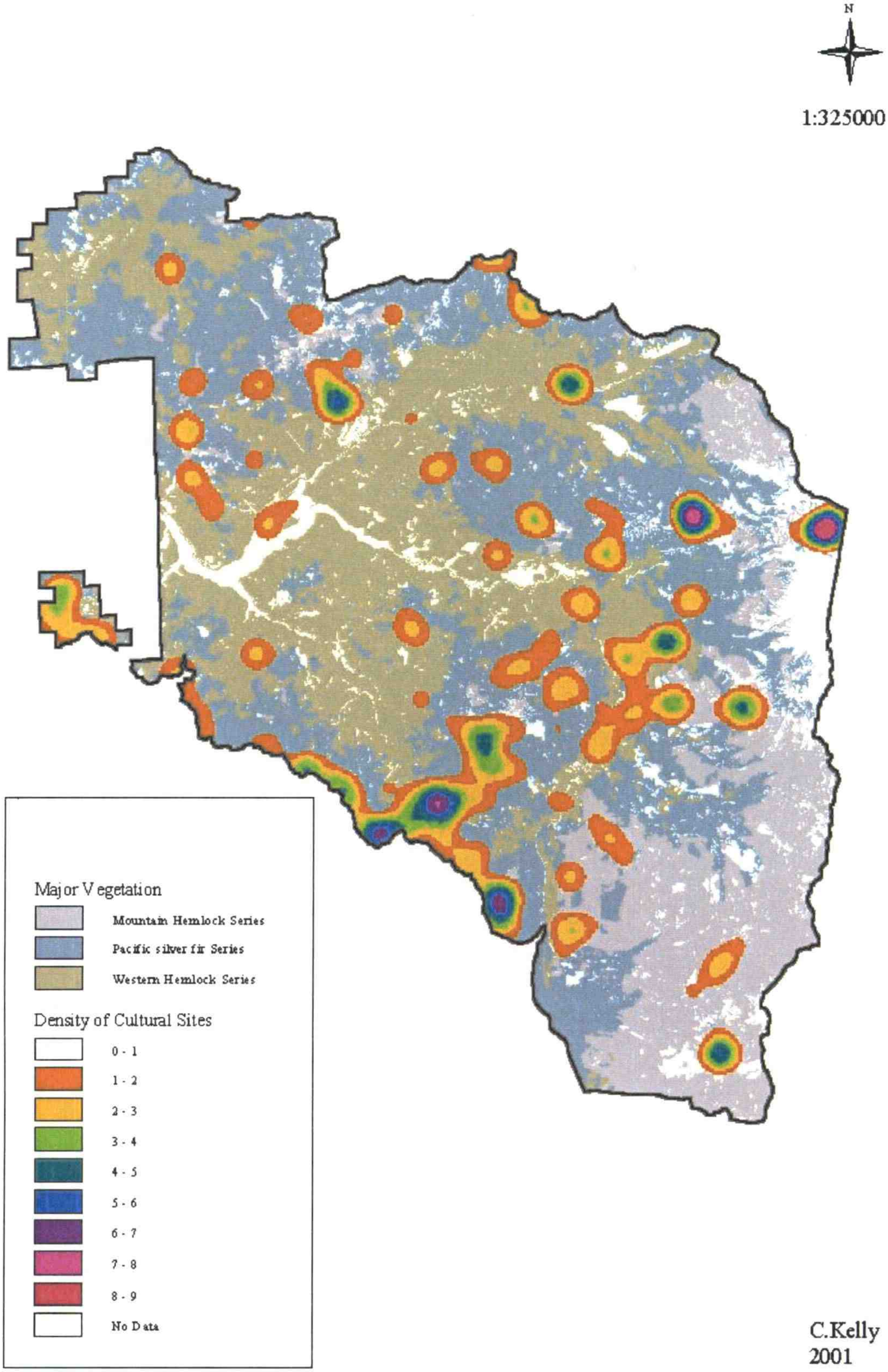


Figure 32: Density of Sites within Zones of Major Vegetation, North Santiam Subbasin.



Distance to Lakes and Ponds

None of the land-use models address specifically the association of sites to lakes and ponds. The reason for this could be due to the difficulty of knowing where all these water bodies are located across their study areas, or that none of the site reports indicated an association with a lake or pond. Numerous lakes and ponds are scattered across the North Santiam subbasin. These non-forested communities are diverse in plant, amphibian and animal life, and would have been important to the seasonal rounds of prehistoric groups. For this reason, I have included these bodies of water in the analysis.

The results (Table 15; Figure 35) show that 2.5 percent of the district covers ground at a distance of 0 to 100 m from a lake or pond. At this distance, a total of 35 sites (10 %) have been recorded. If the sites were randomly distributed, we would expect to find 9 sites (3 %). The large discrepancy between the observed and expected number of sites could be explained if survey coverage deviated substantially from survey of the subbasin as a whole. However, 26 percent of the area (0-100 m) has been surveyed, which is only nine percent more than survey across the subbasin (Figure 34). Highest number of sites associated with lakes and ponds are located above the 1400 m elevation zone, which is where the largest number of water bodies is found. The chi-square statistical test indicates that sites appear in greater frequency within 100 m of an open body of water than might be expected by chance, rejecting the null hypothesis of random site distribution. In terms of density there are only one or two sites at any particular open body of water; areas where there are more than two sites also sustain a meadow.

Table 15: Distance to Lakes and Ponds Chi-Square Test Results and Survey Coverage.

Lakes and Ponds	% of Area	Observed Sites	Expected Sites	Chi-Square	Total Cells	Cells Surveyed	Survey Coverage
0-100	0.025	35	8.975	75.47	320974	83459	0.2600
100-200	0.03	8	10.77	0.71	385082	85368	0.2217
200-300	0.035	8	12.565	1.66	454167	86848	0.1912
300-400	0.037	9	13.283	1.38	480231	79421	0.1654
400-500	0.037	7	13.283	2.97	475825	74654	0.1569
500-600	0.037	6	13.283	3.99	472190	75876	0.1607
600-700	0.036	8	12.924	1.88	466446	74237	0.1592
700-800	0.035	5	12.565	4.55	4522346	67744	0.0150
800-900	0.035	9	12.565	1.01	449625	66662	0.1483
900-1000	0.034	11	12.206	0.12	441506	66385	0.1504
1000-1500	0.157	39	56.363	5.35	2024874	335746	0.1658
>1500	0.502	214	180.218	6.33	6463701	1086554	0.1681
Total	1	359	359	105.42	16956967	2182954	1.9626

Note: Significance fixed at 0.01, 11 degrees of freedom = 24.725

Figure 33: Distance to Lakes and Ponds, North Santiam Subbasin.

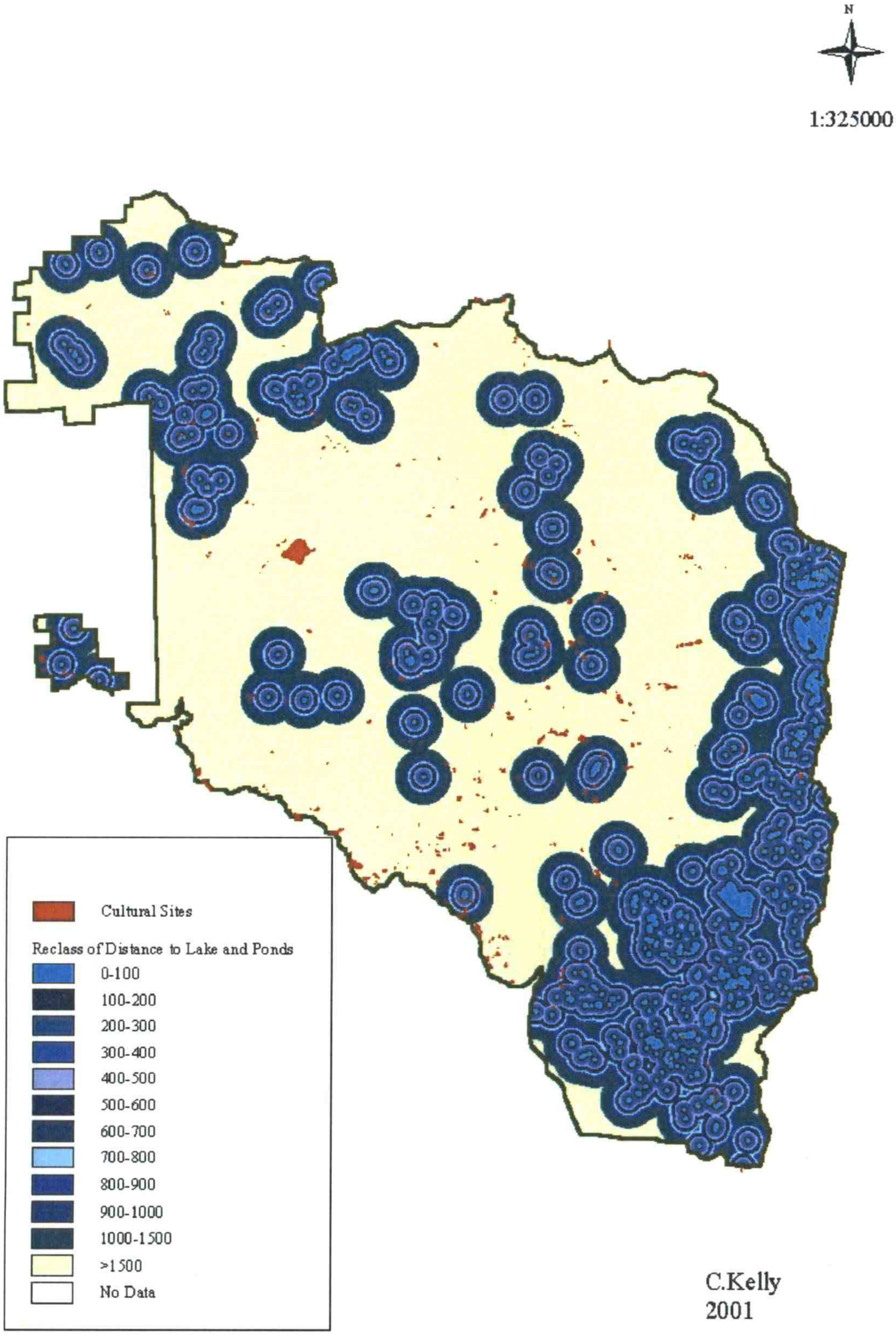
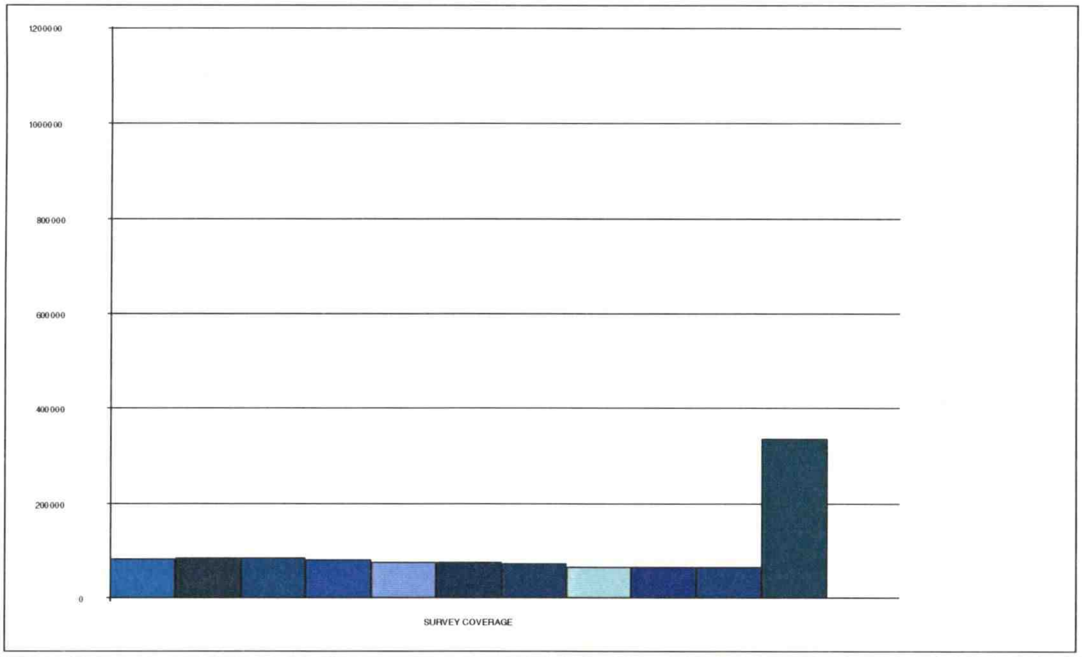


Figure 34: Histogram of Survey and Sites within Zones of Distance to Lakes and Ponds.



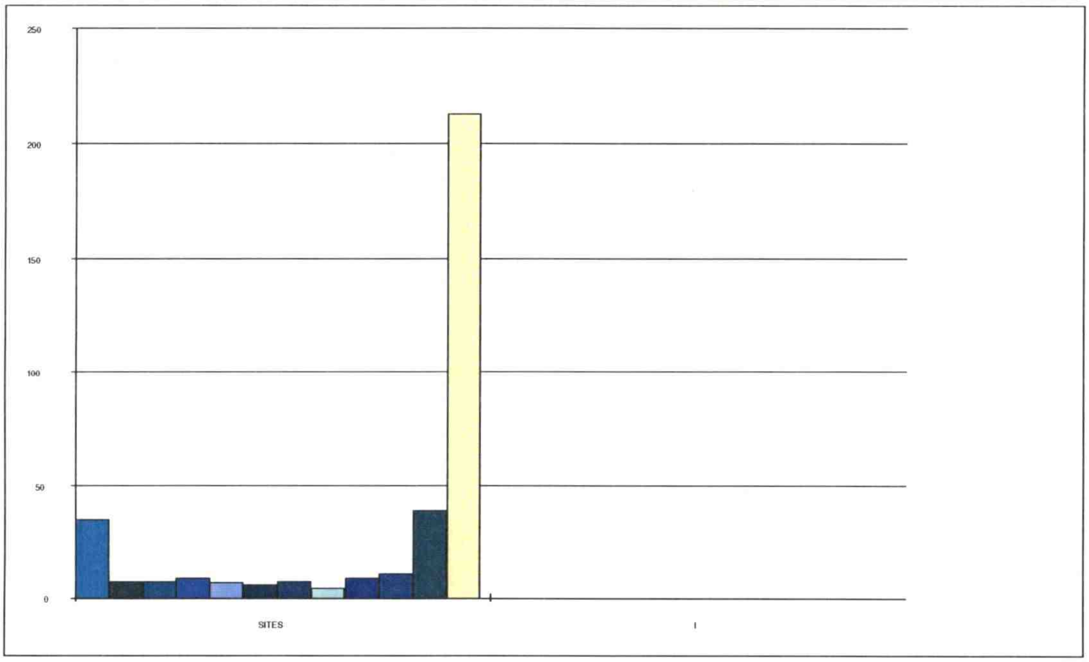
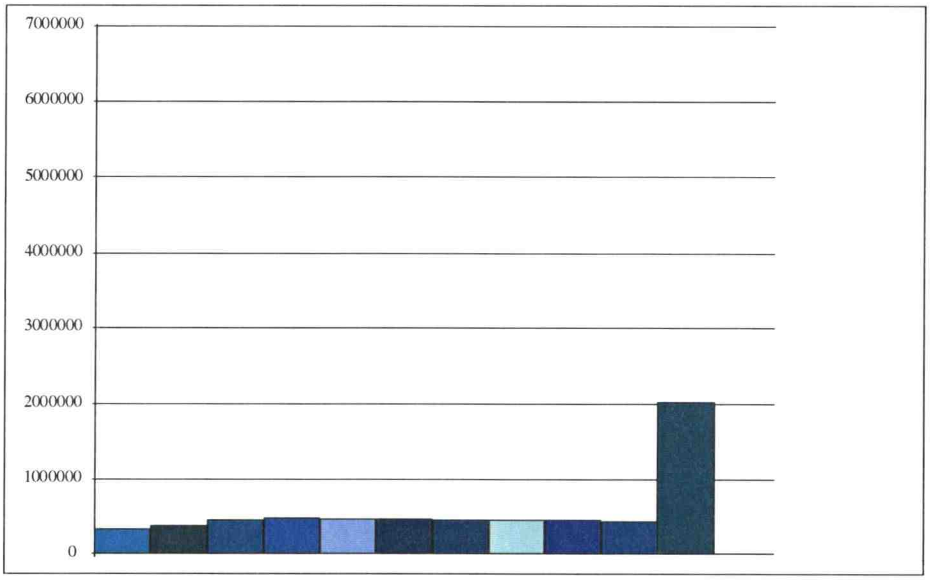


Figure 35: Histogram of Distance to Lakes and Ponds.



Distance to Streams

Distance to streams has often been thought of as a primary predictive variable in site location. In Burtchard and Snyder's land-use models, distance to streams was not considered to be a key predictive variable for lithic scatters. However, it was for culturally modified cedar tree groves, since cedars often grow in moist areas along streams. Table 16 and Figure 37 presents the results of the GIS and chi-square test. It shows that overall sites are not randomly distributed in relation to distance to streams. However, the first four intervals indicate that sites are randomly distributed.

Although there are fewer sites than expected, there are still 129 sites (35 %) found within 200 meters of a stream, which is substantially larger than the other distance intervals (Table 16; Figures 36 and 37). Surveys covered 16 percent of the ground located within 200 m of a stream (Figure 37). Riparian zones are more heavily vegetated than many other areas in the forest, which may account for the lower number of observed sites than expected.

Another possibility is that some streams have steepened slopes, so groups may have been forced to search out flat ground several hundred meters away from a major stream. Also, in late spring or early summer, high water flows in the streams and rivers would have forced groups to locate further from a stream. More likely, this would have been a random choice, especially considering the vast stream network in the western Cascades. Also, groups may have situated in an area that provided a slight breeze far enough from a stream to keep the bugs at bay.

Table 16: Distance to Fish Bearing Streams Chi-Square Test Results and Survey Coverage.

Distance to Fish Bearing Streams	% of Area	Observed Sites	Expected Sites	Chi-Square	Total Cells	Cells Surveyed	Survey Coverage
0-100	0.193	64	69.287	0.4	2489991	388585	0.15606
100-200	0.163	65	58.517	0.72	2103837	326364	0.15513
200-300	0.141	33	50.619	6.13	1810706	296306	0.16364
300-400	0.118	32	42.362	2.53	1523166	264249	0.17349
400-500	0.096	50	34.464	7	1238307	217086	0.17531
500-600	0.073	31	26.207	0.88	951495	168990	0.17760
600-700	0.054	16	19.386	0.59	693231	130337	0.18801
700-800	0.037	26	13.283	12.18	482569	99298	0.20577
800-900	0.026	16	9.334	4.76	329953	68920	0.20888
900-1000	0.018	9	6.462	1	227148	484465	2.13282
1000-1500	0.043	16	15.437	0.02	549840	101834	0.18521
>1500	0.038	1	13.642	11.72	486724	72520	0.14900
Total	1	359	359	47.93	12886967	2618954	4.07091

Note: Significance fixed at 0.01, 11 degrees of freedom = 24.725

Figure 36: Distance to Fish Bearing Streams, North Santiam Subbasin.

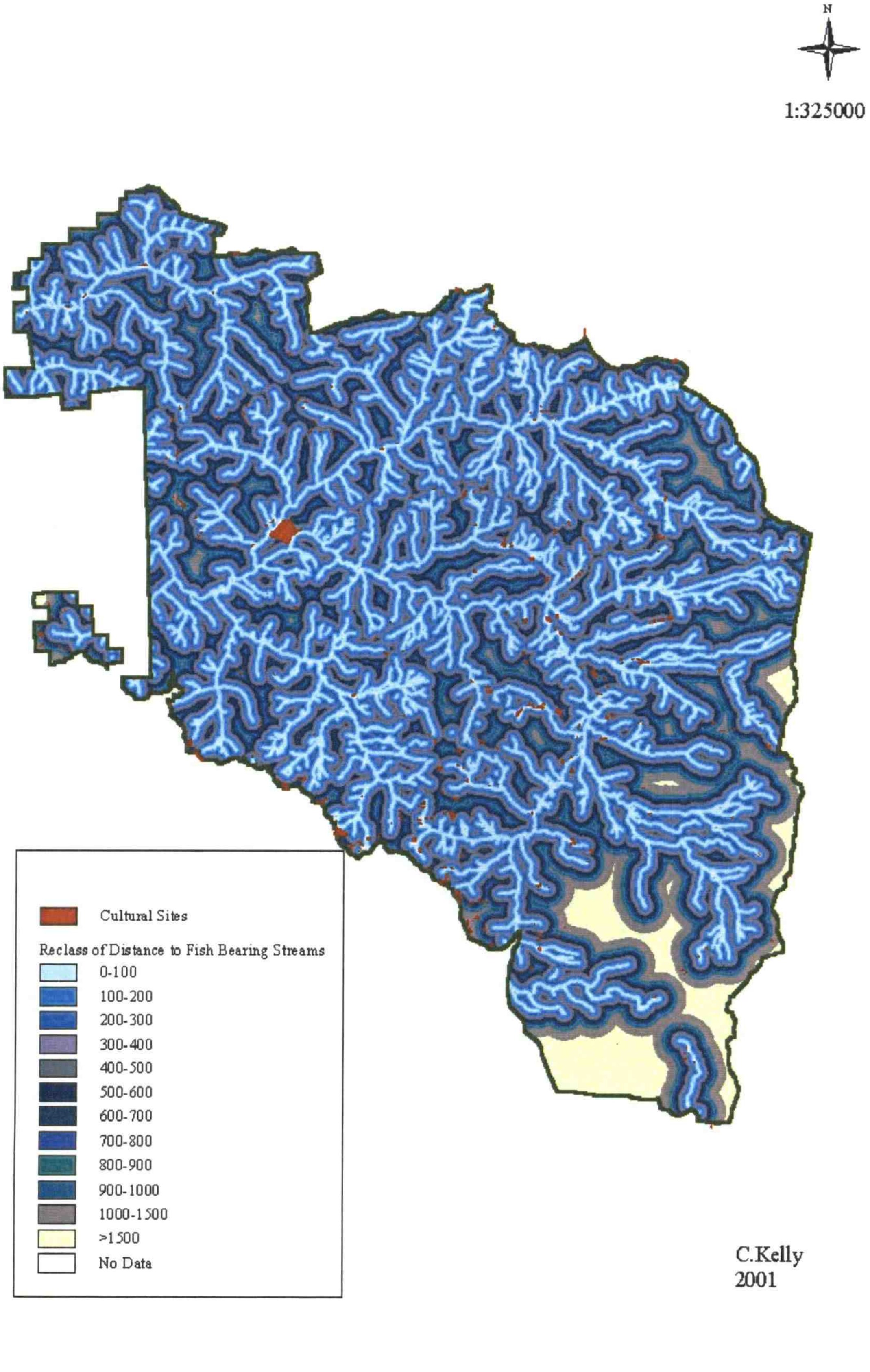
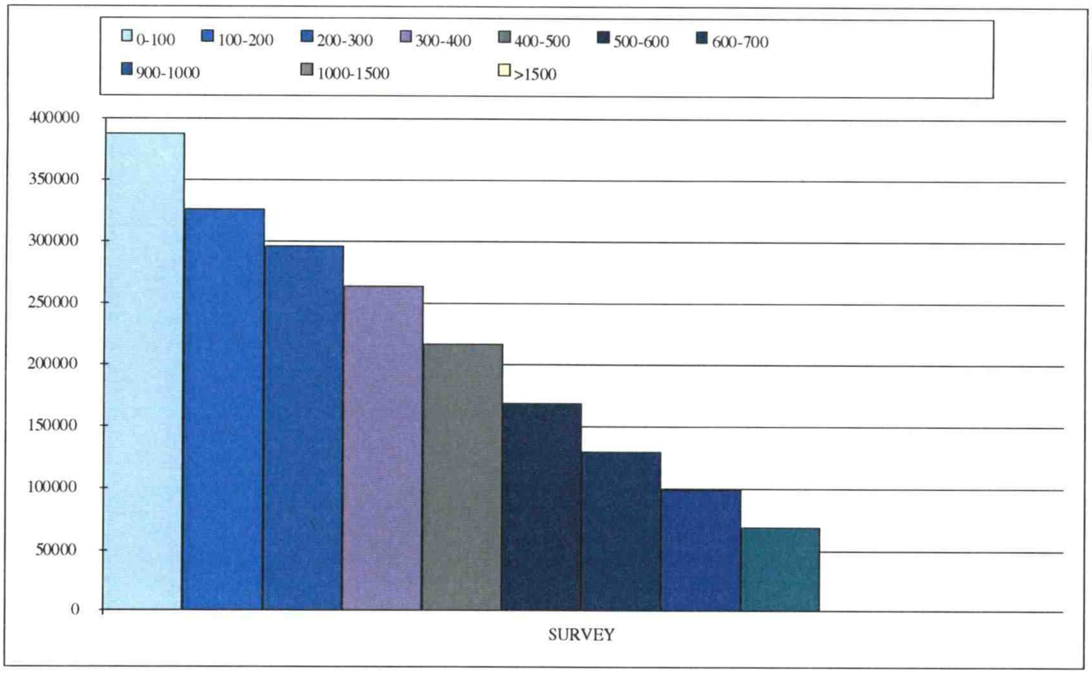


Figure 37: Histogram of Survey and Sites within Zones of Distance to Fish Bearing Streams.



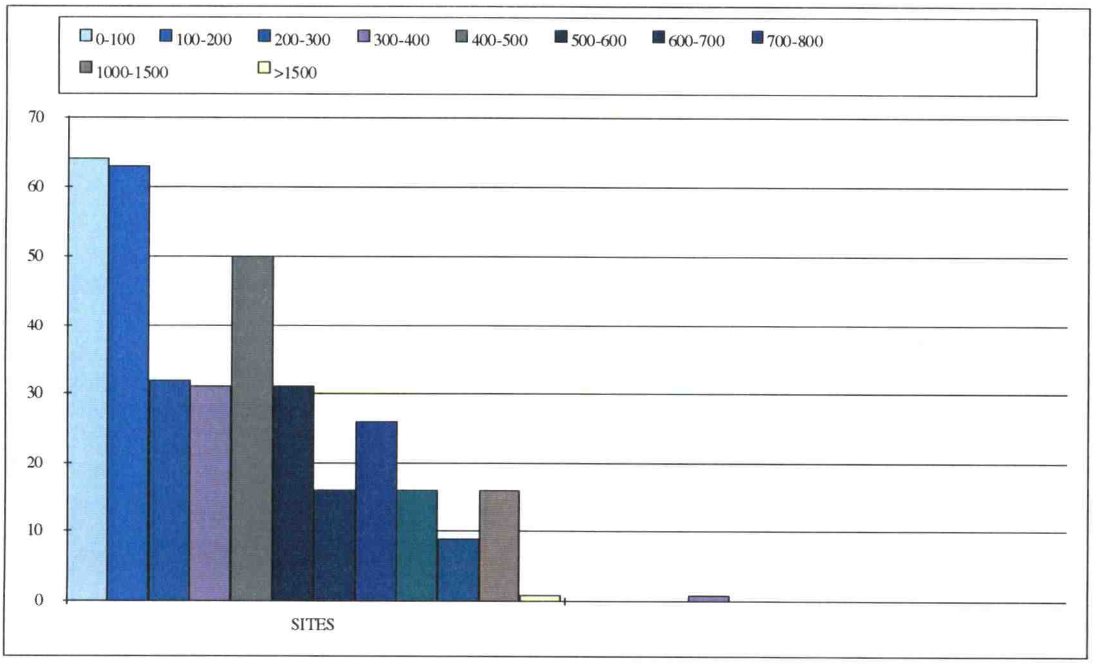
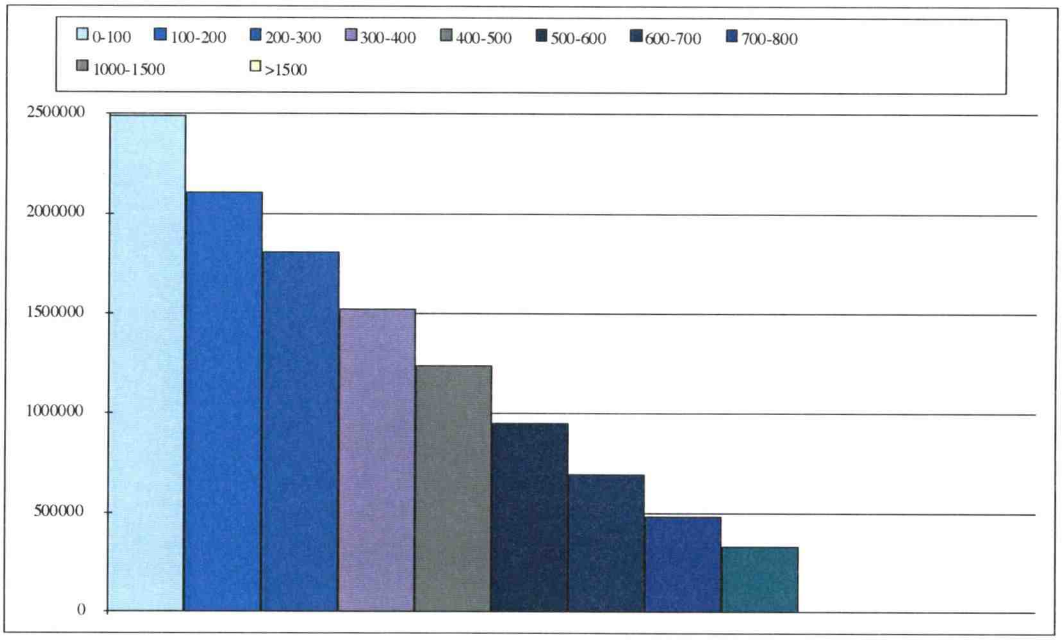


Figure 38: Histogram of Distance to Fish Bearing Streams.



Distance to Trails

None of the land-use models considered whether or not sites are associated with trail locations. I have included it in the analysis because the ethnographic record suggests that trails were important to human groups when crossing the Cascades. Trails provided a means of linking groups to each other within the North Santiam subbasin and to surrounding tribes. Within the subbasin, trails would be especially important due to the high relief in a large portion of the landscape.

The results of the GIS analysis indicate that 21 percent of the district covers ground within 300 meters of a known historic trail (Figures 39 and 40). At this distance to a trail, a total of 135 sites (38 %) have been recorded compared to the expected 75 sites (21 %). Surveys were conducted on 23 percent of this ground (Table 17 and Figure 41). The result of the chi-square statistical test indicates that sites were not randomly distributed, but instead were associated more often than expected with trail locations (Table 17). The trails follow both east-west and north-south ridgelines, providing a means of travel from the valleys below, from the east side of the Cascade Range and north/south through the subbasin. Many of these trails lead to a high-density site area, and often from one high-density area to another. This relationship suggests that human groups were following along the ridgelines to reduce energy costs of movement across the landscape.

Table 17: Distance to Trails Chi-Square Test Results and Survey Coverage

Distance to Trails in Meters	% of Area	Observed Sites	Expected Sites	Chi-Square	Total Cells	Cells Surveyed	Survey Coverage
0-100	0.078	73	28.002	72.31	1005056	288874	0.28742
100-200	0.068	36	24.412	5.5	872898	186219	0.21333
200-300	0.063	23	22.617	0.01	812742	146857	0.18069
300-400	0.06	15	21.54	1.99	769577	122701	0.15944
400-500	0.057	15	20.463	1.46	728986	109239	0.14985
500-600	0.054	13	19.386	2.1	691312	107056	0.15486
600-700	0.051	14	18.309	1.01	659770	99082	0.15018
700-800	0.048	13	17.232	1.04	623723	90488	0.14508
800-900	0.046	9	16.514	3.42	591295	84443	0.14281
900-1000	0.043	13	15.437	0.38	550514	83073	0.15090
1000-1500	0.17	48	61.03	2.78	2189675	325774	0.14887
>1500	0.262	87	94.058	0.53	3386037	539148	0.15923
Total	1	359	359	92.53	12881585	2182954	2.04257

Note: Significance fixed at 0.01, 11 degrees of freedom = 24.725

Figure 39: Distance to Trails, North Santiam Subbasin.

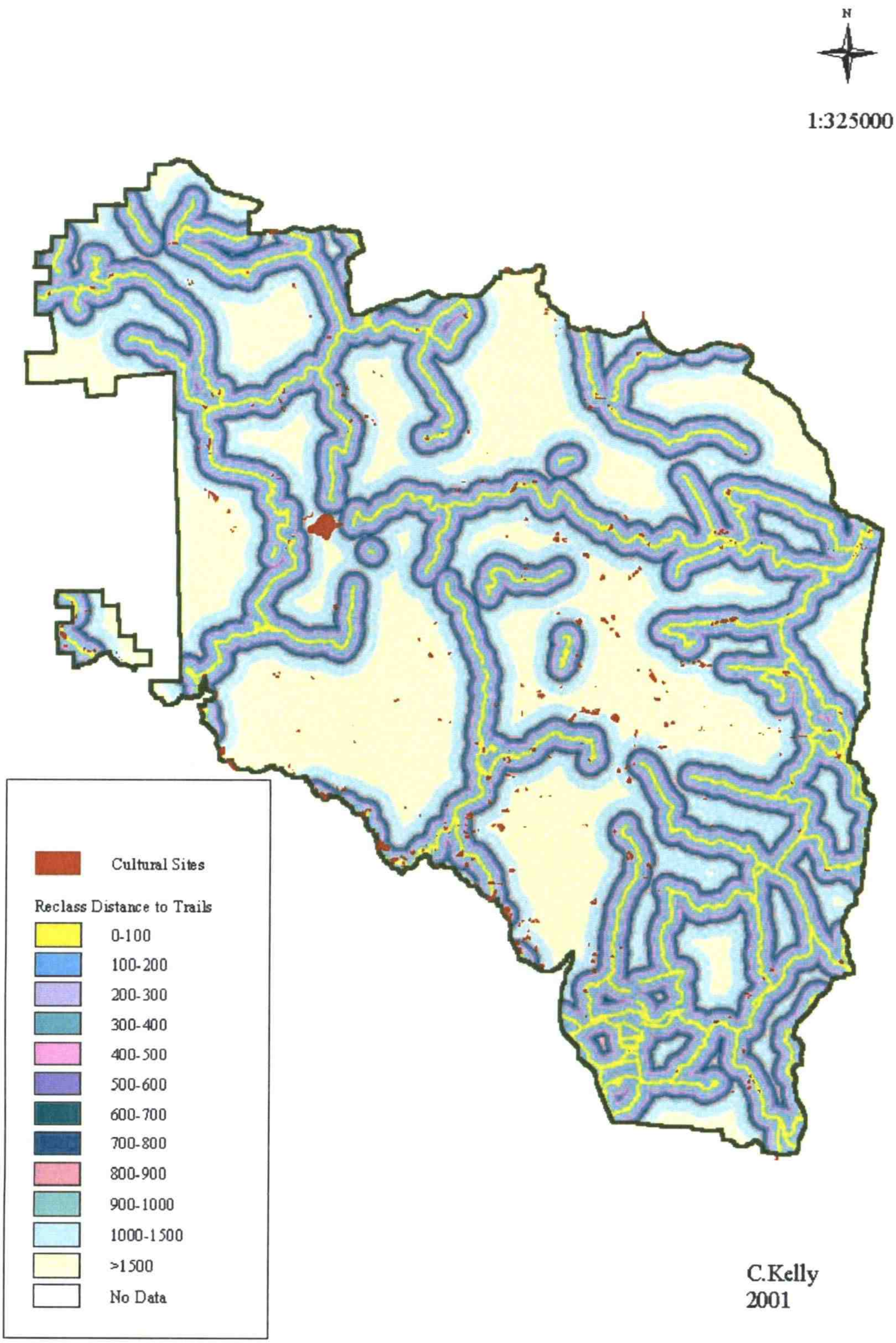


Figure 40: Histogram of Distance to Trails.

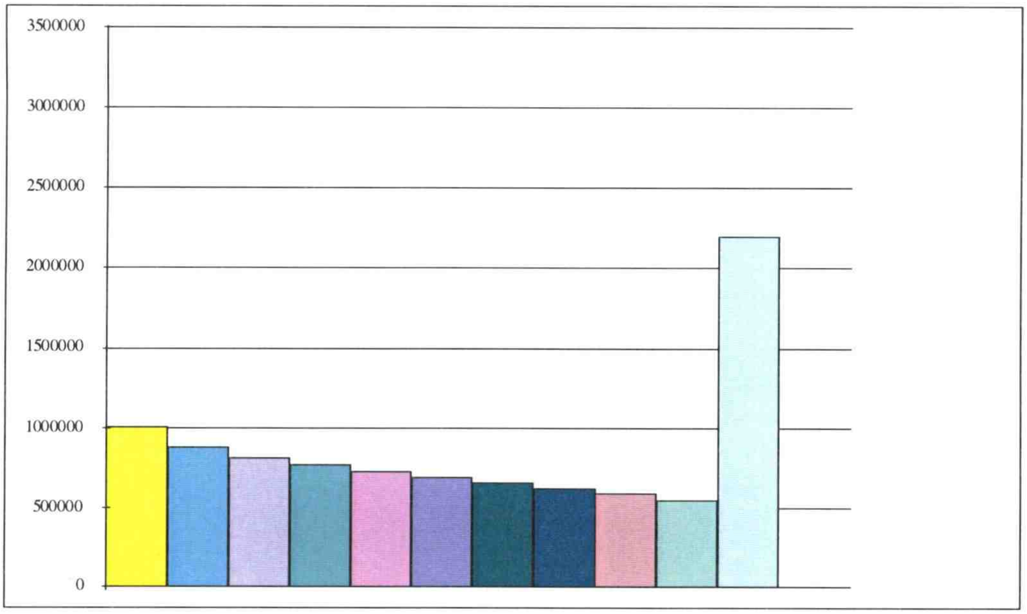
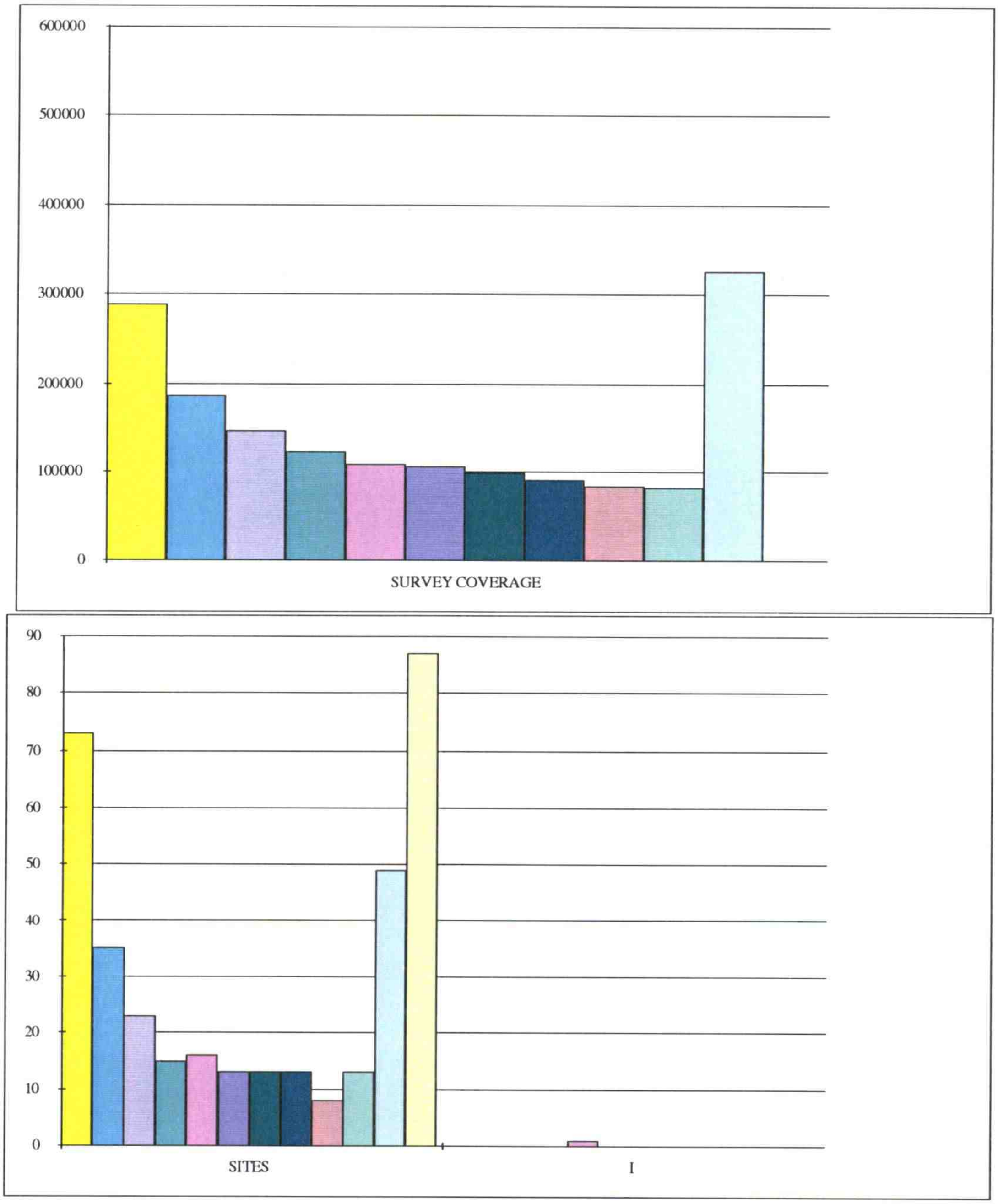


Figure 41: Histogram of Sites and Survey within Zones of Distance to Trails.



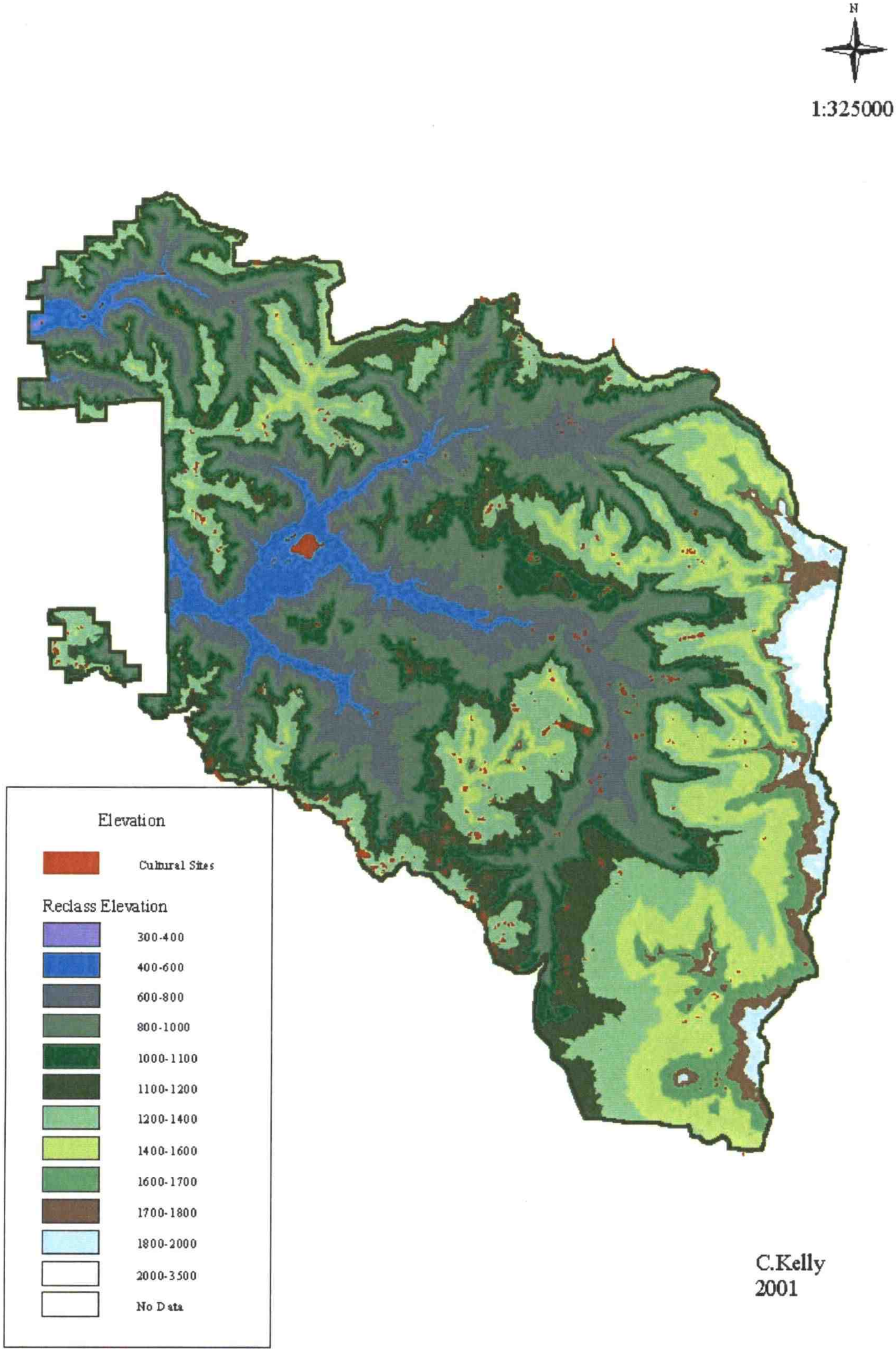
Elevation

Elevation is a proxy for length of growing season, the amount of rainfall and winter snowfall, vegetation type and faunal resource communities, all of which are important to mobile hunter-gatherer groups conducting their seasonal round. The range of the North Santiam subbasin elevation grid is from 352 (1,157 ft) to 3199 m (10,495 ft), with a mean elevation of 1130.5 m (3708 ft) (Figure 42 and 43). If the Cascade land-use models are correct, then there should be bimodal distribution of sites by elevation. The first peak of sites would be located between 1067 (3500 ft) and 1372 m (4500 ft), or in Baxter's case peaking at 1677 m (5500 ft), and the second peak of sites would be located at 610 m (2000 ft) elevation and below, along major stream terraces. Baxter's (1986) model also suggests that sites located in the upper elevations are strictly associated with hunting and huckleberry picking. Sites located between the two elevation peaks would be associated with strictly hunting and travel.

In the North Santiam subbasin, the distribution of sites by elevation does not indicate a bimodal distribution. Site distribution in the subbasin has a bell shaped curve with the highest number of sites (n=128) peaking between 1200 (3900 ft) and 1400 m (4600 ft), gradually thinning out to either end of the elevation extremes (Figure 44; Table 18).

There are fewer sites than expected at the 400 to 600 m (<=2000ft) elevation range based on the chi-square test (Table 18). This number of expected sites is also much less than the land-use models predict. A number of possible reasons can explain the lack of sites at this elevation. First, only 4.6 percent of the district covers this elevation, so many of the lower elevation sites could be located on adjacent lands not administered by the Forest Service. Second, if the land-use models are correct, then most of these lower elevations sites should be adjacent to anadromous fish bearing streams; the ten low elevation sites are located along the Little North Fork Santiam, the Breitenbush and the North Santiam Rivers (now the Detroit Reservoir). Third, many of these riparian areas with the exception of the Detroit Reservoir sustain very thick vegetation, making site visibility difficult. Fourth, the Detroit Reservoir is located at between 457 (1500 ft) and

Figure 42: Elevation, North Santiam Subbasin.



503 m (1650) in elevation, covering the largest tract of low elevation in the subbasin. The Detroit Reservoir, built in the early 1950s, now covers what was once a very broad valley dissected by two major rivers, the North Santiam and the Breitenbush.

A total of 22 sites (6 %) are located between 600 and 800 m in elevation, within the western hemlock vegetation series. These sites are adjacent to or in the vicinity of the two major river systems, the North Santiam and the Breitenbush. The sites above the North Santiam are situated on a bench or stream terrace in proximity to meadow communities or along a Class I tributary to the North Santiam River. The sites located near the Breitenbush River are found on benches and stream terraces within the vicinity of hot springs, meadow communities, or along Class I tributaries.

Fifty-five sites (15 %) have been recorded between 800 (2624 ft) and 1100 m (3600 ft) in elevation, within the transition zone between the western hemlock and the Pacific Silver fir series. These sites are located on a bench, mid-slope bench, or stream terrace in proximity to Class II and III tributaries to the North Santiam and Breitenbush Rivers, along major east-west travel routes. None of these sites are in close proximity to a meadow, huckleberry patch or open body of water.

A total of 191 sites (53 %) are located between 1100 and 1400 m in elevation, on either a mid-slope bench, at stream headwaters or in a saddle. Most of these sites are associated with a lithic material source, a meadow, a huckleberry patch or both, located along the major ridge systems in the North Santiam subbasin. There are three culturally modified tree groves, and an unnamed CCS material source within this elevation zone.

Eighty sites (22 %) are located above 1400 m in elevation, within the upper zone of the Pacific Silver fir and within the Mountain hemlock series. Numerous sites at this elevation are associated with a series of glacial lakes, ponds, subalpine and dry meadows, and huckleberry patches along high elevation travel routes. These high elevation areas would have been accessible from east or west of the Cascade Range from mid to late summer through the first part of fall.

Figure 43: Histogram of Elevation.

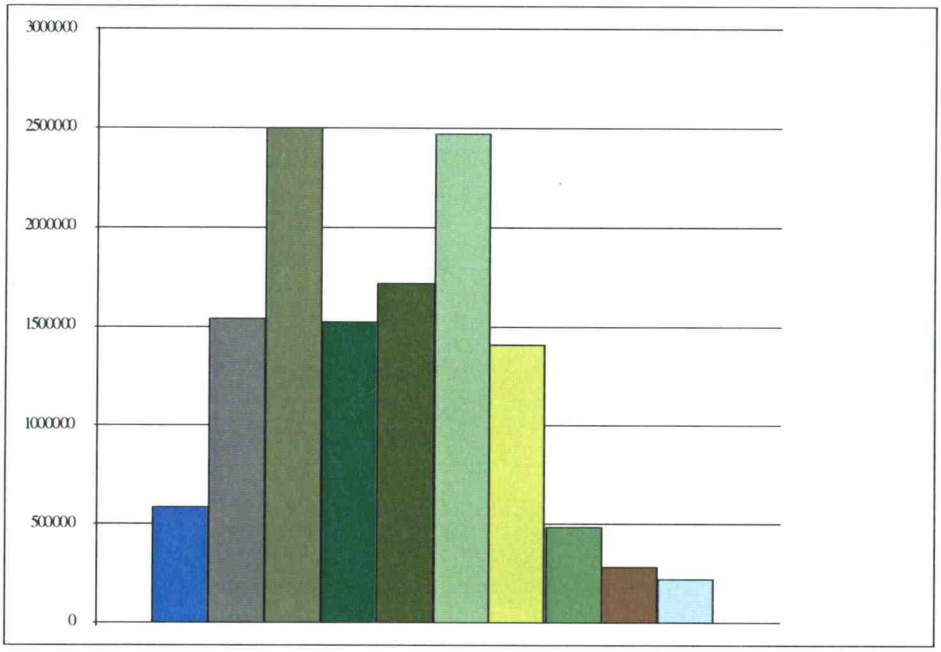
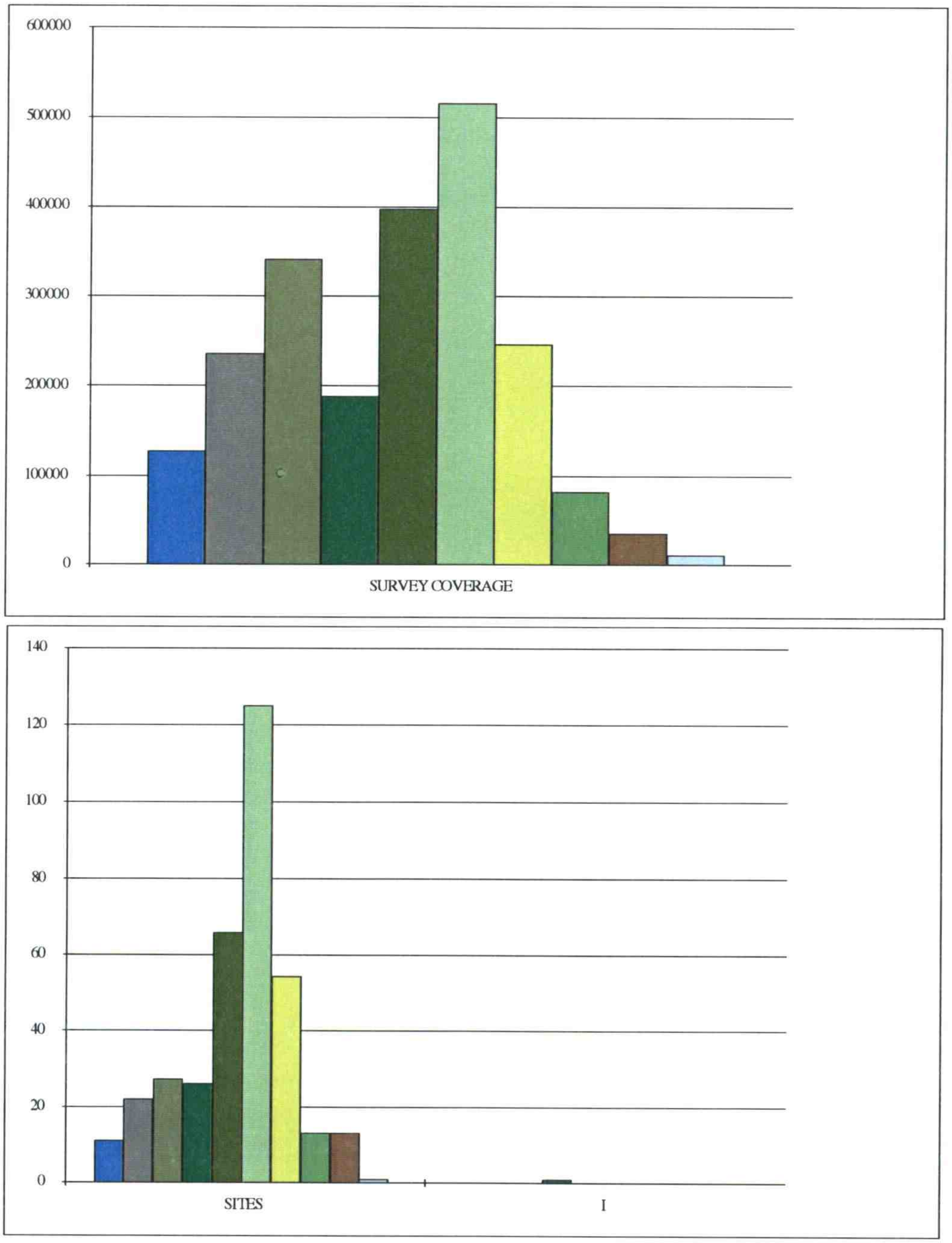


Figure 44: Histogram of Survey and Sites within the Zones of Elevation.



The results of the chi-square test show that 43.5 percent of the subbasin falls between the 1100 and 1600 m elevation, and a total of 245 sites (68 %) have been recorded at this elevation range (Table18). If the sites were randomly distributed, we would expect to find 156 sites (43 %) in this zone. This large discrepancy could be explained if the percent of survey coverage in this zone was higher than in the subbasin as a whole. The subbasin-wide survey coverage totals 17 percent, while the survey coverage for this elevation range is 21 percent, which is not a large enough discrepancy to account for the huge difference between the observed and expected site locations. The chi-square test supports the hypothesis that sites are not randomly distributed by elevation.

Table 18: Elevation in Meters Chi-Square Test Results and Survey Coverage.

Elevation In meters	% of Area	Observed Sites	Expected Sites	Chi-Square	Total Cells	Cells Surveyed	Survey Coverage
300-400	0	0	0		0	0	0
400-600	4.6	10	16.514	2.57	589664	127480	22.0
600-800	11.9	22	42.721	10.05	1543806	236101	15.0
800-1000	19.4	27	69.646	26.11	2500546	342150	14.0
1000-1100	11.5	28	42.362	4.87	1520073	188423	12.0
1100-1200	13.3	66	47.747	6.98	1712250	396909	23.0
1200-1400	19.2	125	68.928	45.61	2473345	515717	21.0
1400-1600	11.0	54	39.49	5.33	1411016	246364	17.0
1600-1700	3.8	13	13.642	0.03	486206	82457	17.0
1700-1800	2.2	13	7.898	3.3	287717	35558	12.0
1800-2000	1.8	1	6.462	4.62	227307	11102	5.0
2000-3500	1.0	0	3.59	3.59	129952		0
Total	1	359	359	113.06	12881882	2182261	

Note: Significance fixed at 0.01, 10 degrees of freedom = 23.209

Discussion

The site distribution pattern in the North Santiam subbasin is divided into five zones by elevation, corresponding to site density pattern and key predictive variables (Figure

45). Within the first zone, located below 600 m (1968 ft), sites are directly associated with Class I anadromous fish-bearing rivers within the Western hemlock series. Only two sites in the subbasin have been excavated within this zone. The limited excavation data suggests that these sites were used on a repeated basis where the reduction of quarry blanks and the maintenance and rejuvenation of projectile points and other hunting tools took place (Chapter 2).

Thirteen percent of the projectile points (Chapter 4) were collected in this zone. These tools were manufactured mainly from Obsidian Cliffs and Devil Point (Table 19). One arrow point manufactured from Silver Lake/Sycan Marsh was located along the travel corridor between the hot springs and the broad valley at the confluence of the North Santiam and Breitenbush Rivers. Five of the low elevation sites are located at the confluence of these two major river systems. Extensive damage from reservoir construction has occurred at the sites on the reservoir terraces. None of the reservoir sites have been excavated, but projectile points have been collected from most of these sites suggesting use during the three Archaic periods. Coupled with the ethnographic record, it suggests that a variety of Indian groups were occupying this location until the 1920s. The sites along the reservoir could have potentially been use by groups as long term base camps situated between the low elevation winter camps and the high resource zone base camps. If the land-use models are corrected we should see more winter camps within this zone especially below 600 m. It is more probable that groups spent the winter along the North Santiam below 400 m in elevation in the present day towns of Gates and Mill City. The notion of a winter camp in the Cascades has not been proven archaeologically. Further investigation may help clarify how the sites in the elevation zone fit into the pattern of prehistoric land-use.

The second zone is located between 600 and 800 m (2000 to 2600 ft) in elevation within the Western hemlock series. Sites in this zone are associated either with the upper reaches of the North Santiam and Breitenbush rivers or their Class I tributaries. No sites have been excavated within this zone. However, the one high-density site cluster is located in the vicinity of the Breitenbush River hot springs and trails that lead to the broad valley at the confluence of the North Santiam and Breitenbush Rivers. Only five percent of the projectile points, manufactured from Obsidian Cliffs and Devil point, were collected from this zone (Table 19).

The third zone, located between 800 and 1100 m (2600 to 3600 ft) in elevation, is the transition zone between the lower and upper elevation sites in the subbasin. Most of sites are associated with Class II, III or IV streams and are not associated with a non-forested community or huckleberry patch with the exception of a few bordering Zone 4. One large clump of culturally modified trees is located in a steep drainage along a well-known historic trail route within the largest moderate-density site cluster in this elevation zone (Figure 46).

Three sites have been excavated in this zone (Chapter 3). One site was used a temporary resting place along a travel route (35MA68); the other site served as part of larger travel corridor connecting to various resource areas to the east and along the west flanks of the Cascades (35LIN119); and the third site is located in the moderate density site cluster near the secondary obsidian source (35LIN374). The artifact assemblage from this site indicates that some primary lithic reduction was conducted on site. Seventeen percent of the projectile points discussed in Chapter Four have been collected from this zone (Table 19). These points were manufactured from Obsidian Cliffs and Devil Point glass and suggest use mainly during the Middle Archaic.

Only moderate-density site clusters are found within this zone, and the largest is near a secondary obsidian source (Figure 46). The sites within the moderate-density cluster are located on or near a travel route, within two km or less of Grizzly Creek, which contains obsidian cobbles chemically sourced to Devil point. It is possible that hunter-gatherer groups were locating in this area because of the close proximity to the secondary obsidian source and to travel routes that lead east to the high elevation meadows, huckleberries and open bodies of water; or west to prime huckleberry grounds along the southwestern boundary. Further investigation at these sites is needed to make this determination.

The fourth zone is located between the 1100 and 1400 m (3600 to 4600 ft) in elevation and provides the most diverse resource base in the subbasin. A large number of high-density site clusters are located across this zone (Figure 46). One cluster is associated with an unnamed CCS material source. The other clusters are associated with huckleberry patches, meadow communities, and mid-elevation lakes. All of the high-density site areas are found along major ridge systems, mainly within the Pacific Silver fir series. Three clumps of culturally modified cedar trees are located within this zone. Two of the culturally modified tree clumps are located along a major east-west travel routes between two lithic material sources, in areas that sustain large huckleberry patches. The third clump of trees is located in the northern portion of the district along a travel route that leads from the Little North Fork Santiam River to the North Santiam River, in an area that also sustains large huckleberry patches.

Most of the excavated lithic sites in the subbasin occur within this elevation zone. The data suggest that these sites were located along major travel routes, and served a variety of purposes from a temporary camp or resting place along a ridgeline, to more intensively used base camps in areas with a high diversity of floral and fauna resources. The radiocarbon dates (n=3) and projectile points recovered from the excavations indicate that occupation occurred at these sites from the Early Archaic into the Late Archaic period (Chapters 2). A variety of tool production activities took place at these sites, along with plant processing. As Table 19 indicates, the highest percentage of projectile points (57%) representing the most diverse obsidian source material was collected from this zone.

This suggests that prehistoric groups from both east and west of the Cascades were traveling along these major ridges systems to access the open meadows, huckleberry patches, prime hunting grounds and lithic material sources as part of their seasonal procurement round. These non-forested communities, concentrated between the 1100 and 1400 m elevation zone, sustain a diversity of plant and animal resources that would have attracted human groups for thousands of years to hunt and procure a variety of important plant resources.

The fifth zone is located above 1400 m (4600ft) in elevation is mainly within the Mountain hemlock vegetation series. This elevation range sustains numerous high elevation glacial lakes, ponds, meadows, and huckleberry patches. Four high-density site clusters are located within this elevation zone (Figure 46). One is associated with a combination of subalpine meadows, glacial lakes and ponds, and huckleberries. The second site cluster is located in the southern portion of the district, among a series of glacial lakes and dry meadow communities. The third cluster is associated with a glacial lake and the Grizzly Flats meadow basin; and the fourth is associated with the Devil Point Obsidian source (Figures 45 and 46). The rest of the sites are not clustered but spread out in this upper elevation zone near the non-forested communities and ridgeline travel corridors. Four known rock cairn sites are located within this zone. Three of the rock cairns are located on the fringe of moderate to high-density site clusters in the vicinity of ethnographically documented travel routes. Only seven percent of the projectile points were collected from this zone (Table 19). These points were manufactured from Obsidian Cliffs, Newberry Volcano, Devil Point, and Carver Flow. None of the sites in this zone have been excavated, so site function cannot be determined.

Figure 45: Elevation Zones, North Santiam Subbasin.

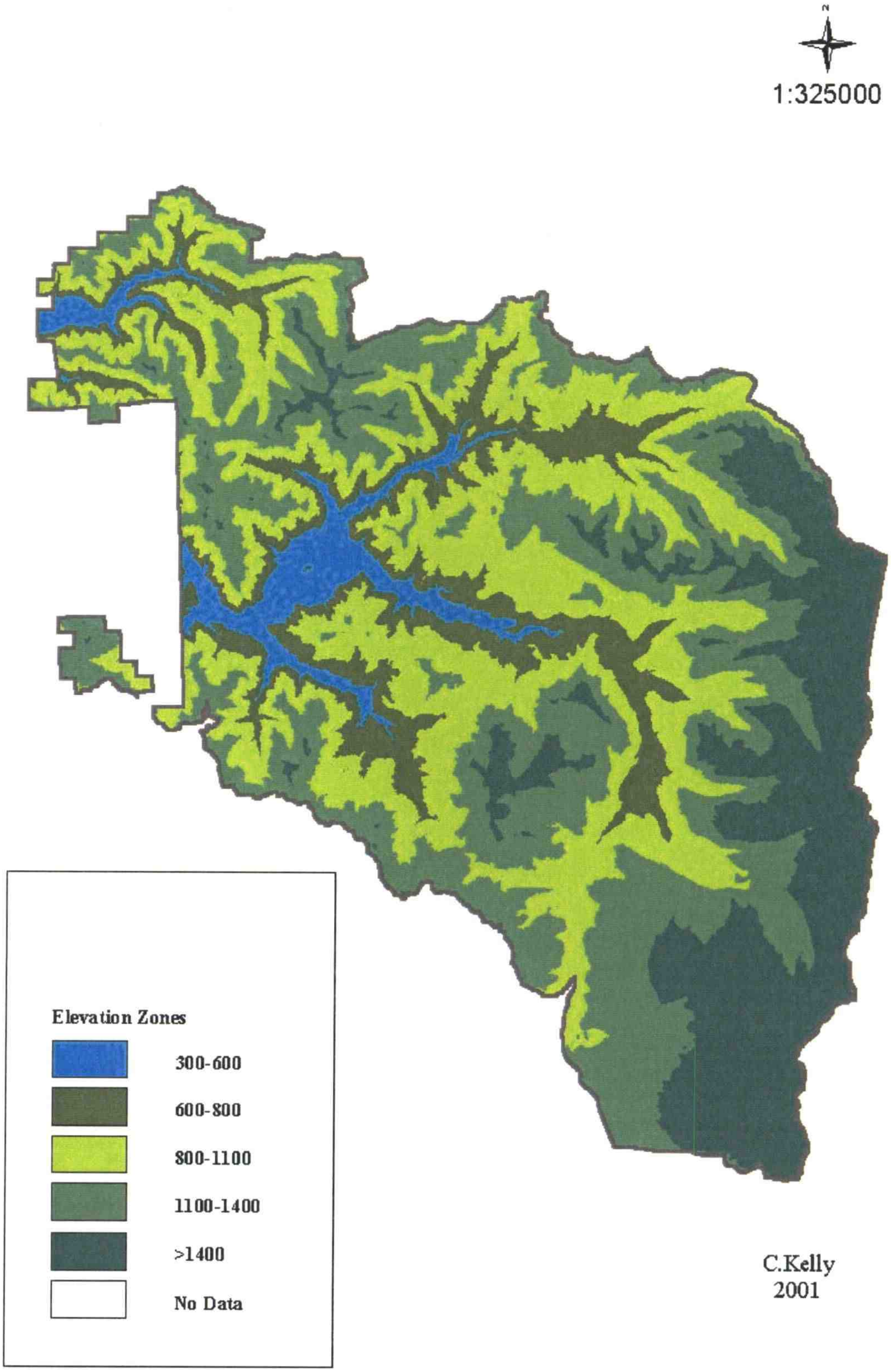
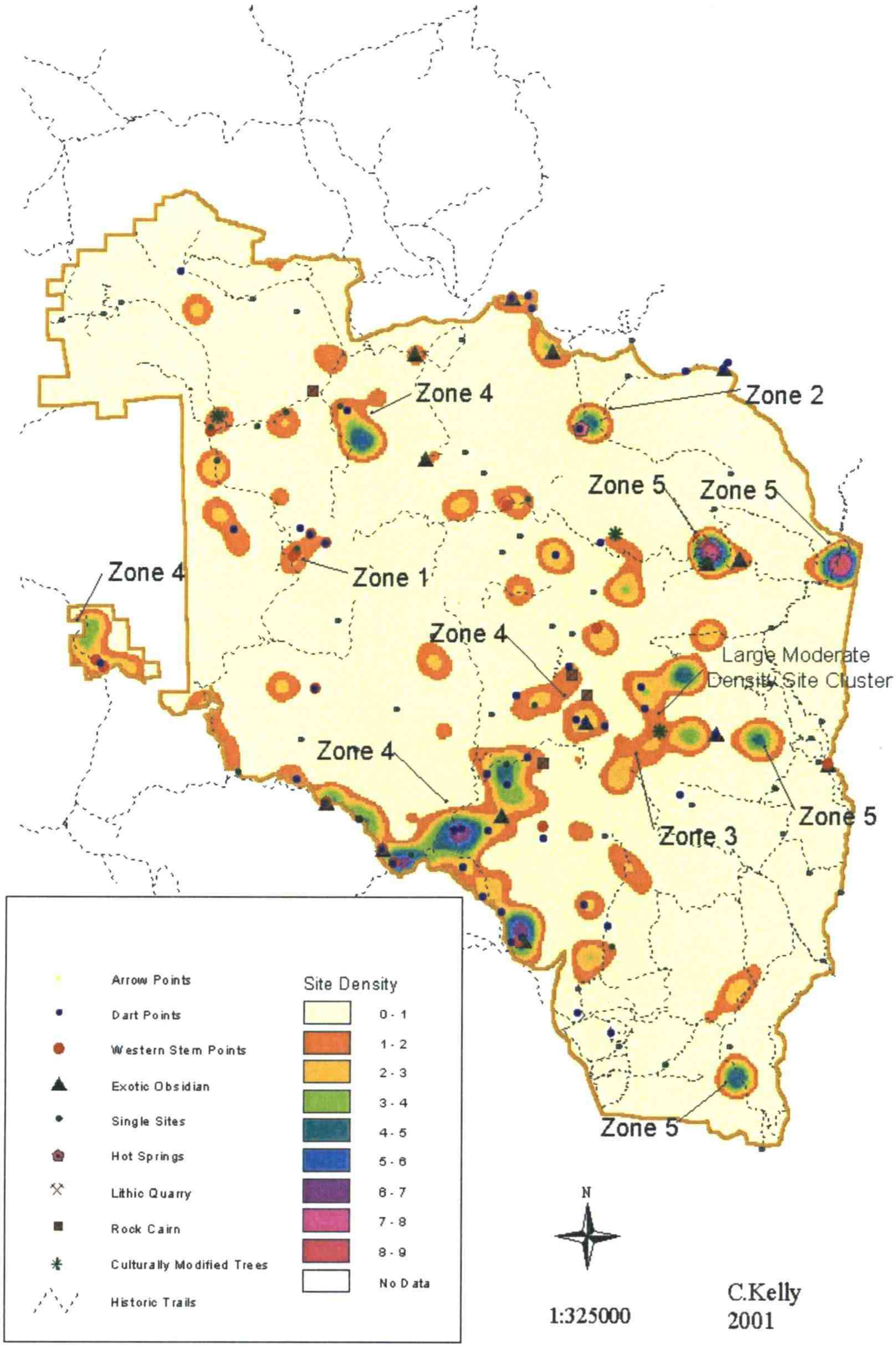


Table 19: Distribution of Projectile Points and Source Material Within the Five Elevation Zones.

	Zone I	Zone II	Zone III	Zone IV	Zone V
Western Stemmed	4 (11)	1 (1)	1 (1)	10 (11)	1 (1)
Foliate	2 (3)	4 (6)	11 (16)	26 (44)	0
Dart	4 (4)	3 (3)	8 (15)	29 (38)	4 (4)
Arrow	2 (6)	0	1 (1)	14 (15)	9 (9)
Percent of Tools	13%	5 %	17 %	57 %	7 %
Obsidian Sources	OC, D.P, SL	O.C., D.P.	O.C., D.P.	O.C., D.P., N.V., M.B., M.L. B.B., J.S.	O.C., N.V., D.P., C.F.

(First number represents the number of sites; the number in parentheses represents the number of tools). O.C. = Obsidian Cliffs, D.P. = Devil Point, S.L. = Silver Lake, Sycan Marsh, N.V. = Newberry Volcano, M.B. = McKay Butte, M.L. = Medicine Lake Highland, B.B. = Bald Butte, J. S. = Juniper Springs, C.F.= Carver Flow.

Figure 46: Site Density Pattern in Relation to Elevation Zones.



Summary

GIS has provided the opportunity to examine the relationship between sites and key environmental and social variables. Chi-square statistical tests were conducted to determine if sites were significantly associated more often than expected with the various variables. The cultural survey coverage was overlaid with each of the variables to determine if more sites were associated with a particular variable because there was a higher percentage of survey coverage for that area than the subbasin as a whole.

The site distribution pattern in the subbasin was found to be significantly associated with meadow communities, lakes and ponds, huckleberry patches, trails, the major vegetation zones, elevation, lithic material sources, and hot springs. Only two variables, aspect and fish-bearing streams, are not considered key predictive variables for site location. Based on the site distribution pattern, the subbasin was divided into five elevation zones corresponding to the density of sites and key predictive variables. Zones four and five provide the highest diversity of resources and the largest number of high-density site clusters. The data reveal a pattern of long-term repeated used of the above resources over the past 10,000 years by local hunter-gatherers and more distant groups east of the Cascades.

CHAPTER 8
CONCLUSION AND RECOMMENDATIONS

Prehistoric land-use patterns were examined in the North Santiam subbasin, on the western slopes of the Cascade Mountains. Two main objectives were met, 1) obsidian sourcing and hydration analysis conducted on projectile points recovered from the surface and subsurface of the subbasin have provided evidence for early occupation in the subbasin; and revealed patterns in mobility, social interaction, and the use of raw material during the Archaic; 2) the adaptive strategies of past hunter-gatherer groups were addressed by determining which environmental and social strategies were important during the Archaic and Ethnographic periods. The limited database for the North Santiam subbasin made it difficult to consider the size and organization of social groups, the relative degree of sedentism and mobility, and how these changed over time.

The results of the sourcing and hydration analysis reveals that the mean hydration values for the different artifact forms in general decreases in each obsidian type as one moves downward in order. The Western Stemmed projectiles, recovered from 17 localities (Chapter 4), is a much better chronological indicator for identifying early occupation in the western Oregon Cascade Mountains than the "Cascade" point. The Middle Archaic period is best represented based on the number of excavated sites dating to this period (Chapter 3) and the recovery of broad-neck projectile points from 55 localities scattered across the subbasin (Chapter 4). The Late Archaic is represented at 25 localities based on the recovery of narrow-neck arrow points. The hydration rim measurements suggest that hunters continued to use the dart and atalatl technological system concurrently with the bow and arrow hunting system during the Late Archaic; and places the beginning of the Late Archaic in the subbasin closer to 2000 B.P. This may be why there have been so few arrow points found on the district compared to the broad neck dart points. All of the arrow points are corner or basally notched, which may reflect a slightly more effective hafting technique than side-notching (Beck 1998).

Obsidian Cliffs, an important lithic source both locally and regionally, is the most common material found at sites in the North Santiam subbasin. This glass is found in a variety of stages of manufacture, suggesting it was not derived strictly from trade. The dominance of this material for fashioning projectile points stays consistent during all three archaic periods. Obsidian Cliffs glass has been found in pre-Mazama components that date from 11,000 to 7,000 B.P. in eastern Oregon (Connelly 1999) and Washington (Galm and Gough 2000), signifying that this source material was accessible (not fully glaciated) to local and/or far reaching groups during the Late PaleoIndian and Early Archaic periods. Devil Point material is the second most common source used in the subbasin and dominates assemblages in close proximity to the source. The prevalent use of Devil point reflects a prolonged pattern of acquisition through embedded procurement (Skinner 1997).

All of the obsidian sources outside of the west slopes of the Cascade have occurred as finished tools. Newberry Volcano is the third most common obsidian found in the subbasin and is represented during the Middle and Late Archaic. The number of source materials found in the North Santiam subbasin does not change dramatically throughout the Archaic but the diversity of source material does, suggesting the possibility of contact with more distant groups or extended mobility with the introduction of the horse.

The three Cascade land-use models presented in Chapter Five detailed specific environmental variables considered important to past human groups when selecting a particular area on the landscape for repeated use. The purpose of testing the models was to predict where sites are most likely to be found during an archaeological survey in order to protect them from future land disturbing activities; and to contribute to the local and regional prehistory. The predictive variables in the Cascade models include slope, ridge systems, river terraces, and distance to meadows communities. During this study, it was assumed that sites were not randomly distributed across the landscape, instead hunter-gatherer groups chose a particular location based on the natural environment. It was also assumed that many of the environmental variables have survived to modern times and are represented by the presently available data. The analysis was conducted using ArcView

Spatial Analyst, a grid based system. The variables used in the analysis include distance to meadows, to streams, to lakes and ponds, and major vegetation, historic trails, aspect, slope, elevation, cultural sites, and cultural survey.

The results of the GIS analysis and the chi-square test confirm the strong association of sites in the North Santiam subbasin to the above predictive variables. Land-use patterns in the North Santiam for the most part, reflect a combination of all three proposed models presented in Chapter Five. Unlike the tested models, the elevational site distribution pattern reflects a bell shaped curve in the subbasin. Elevation is a proxy for length of growing season, the amount of rainfall and winter snowfall, vegetation type and faunal resource communities, all of which are important to mobile hunter gatherer-groups conducting their seasonal round. The site distribution pattern within the subbasin has been divided into five elevation zones corresponding to the site density pattern and key predictive variables.

For the North Santiam subbasin, high-density site clusters (more than 3) are found on relatively flat ground significantly associated with wet, moist (including subalpine), and dry meadows, huckleberry patches, hot springs, and lithic procurement areas located along major ridge systems that were used as travel routes. The highest cluster of sites is located on the southeastern boundary of the study area. This area is located at the confluence of two major ridge systems that were used as east-west travel corridors throughout the archaic. A site density map (Figure 48) using the 359 prehistoric site locations and 355 prehistoric isolated find locations was created for comparison. All of the high-density areas expanded, supporting the importance of these areas for repeated use by hunter-gatherer groups.

Moderate-density (2 to 3 sites) site clusters are adjacent to lakes and ponds, near cedar groves, secondary obsidian sources and adjacent to Class I, II, and III streams. The locations of the culturally modified trees along major travel routes suggests that groups were gathering the cedar bark as part of their regular procurement rounds in route to productive huckleberry grounds and non-forested communities.

Burtchard's model indicates that the lowest density of sites will be found on moderate to high slope landforms not associated with any of the above resources. This is not the case in the North Santiam subbasin. Approximately 45 sites do not have another site within one square mile or more (Figure 47). However, most of these sites are scattered across the elevation zones associated with a lake, wet meadow, ridge-top trail, or Class I, II, III, or IV river or stream.

Many of the high-density site clusters not only are located near key predictive variables but they contain obsidian from outside of the western Oregon Cascades and projectile points that represent use during all three Archaic periods. This pattern reveals long-term repeated use of meadows, huckleberry patches, and lithic material sources located along travel routes by local hunter-gatherer groups, and more distant groups east of the Cascades. In general, it appears that use of the Cascades intensified during the Middle Archaic, and this intensification continued in the Late Archaic along with contact with more distant groups. Based on the artifact assemblages from excavated sites, the main activity consisted of the manufacture and maintenance of lithic tools and biface reduction, with some plant processing. It is important to remember that we are seeing only a portion of the site. The acidic soils, created from the wet environment of the west Cascades, decomposes organic artifacts quickly; leaving us with only a portion of the artifact record.

Huckleberry picking and hunting were two very important reasons for using the uplands, but based on the location and types of sites, they were not the only reason groups made trips into the uplands. Contact with other groups would have been especially important for marriage alliances and trade. The hot springs, lithic material, cedar bark, vision quests, fishing and the gathering of other plant resources of economic

Figure 47: Site Density Pattern in Relation to Huckleberry Patches, Meadow Communities, Trails, Exotic Obsidian, and Point Types, North Santiam Subbasin.

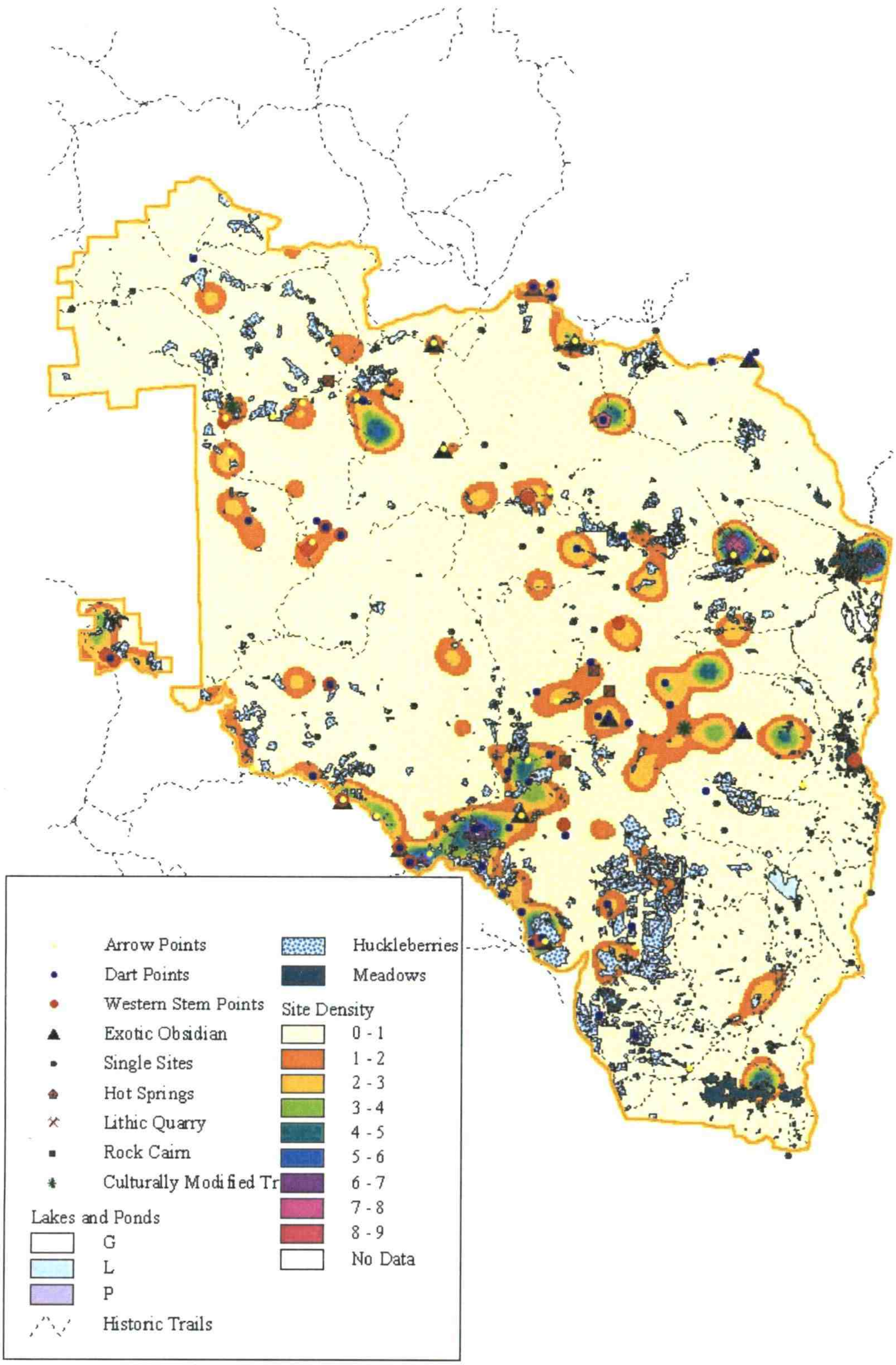
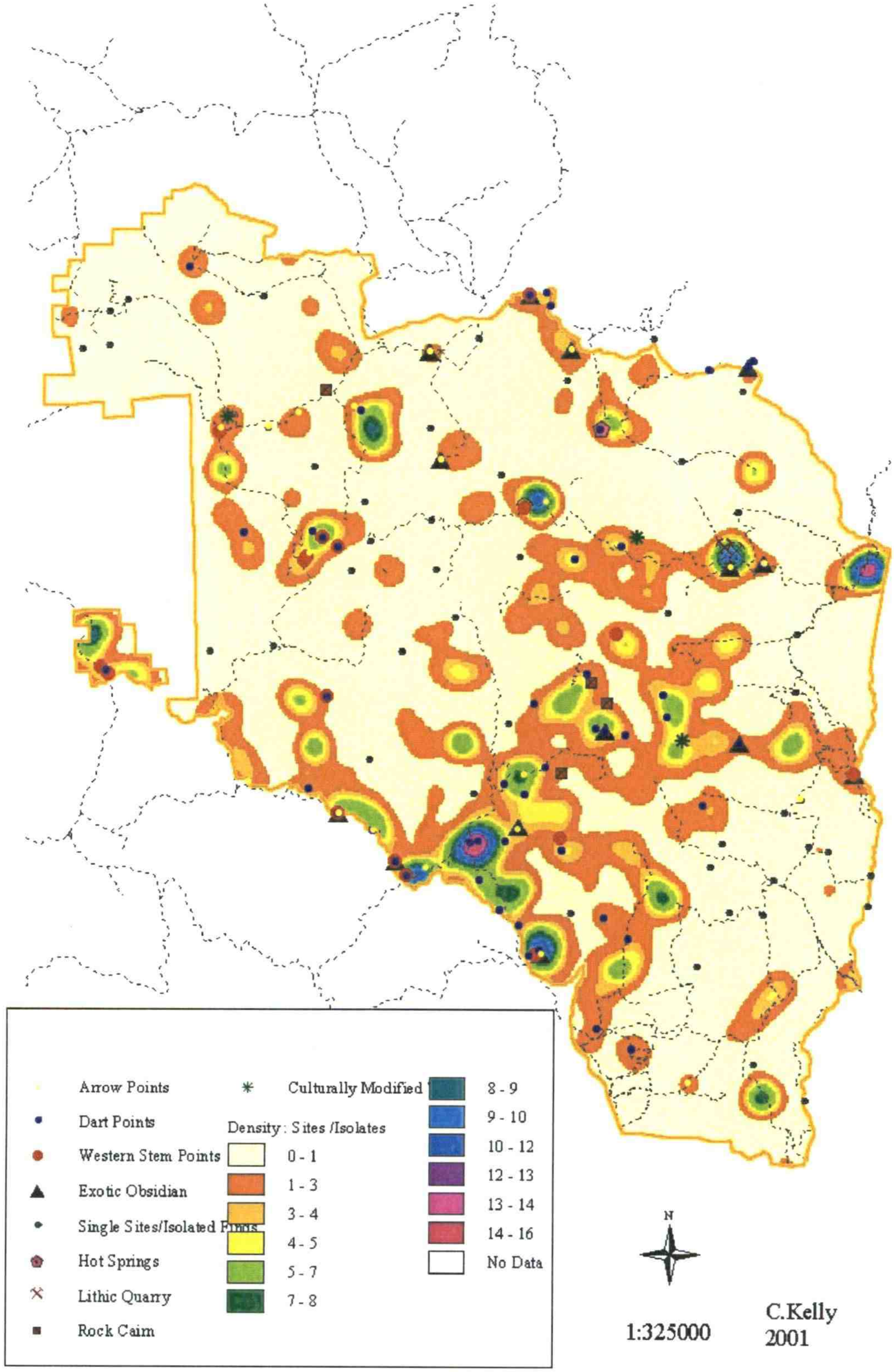


Figure 48: Density of Sites and Isolated Finds, Exotic Obsidian, and Projectile Point Types.



importance were also critical aspects of their broad-ranging seasonal quests into the uplands. Further obsidian analysis on artifacts from a variety of assemblages from each of the elevation zones would help clarify the issue of mobility, contact with other groups, and direct or indirect procurement strategies.

In general the site distribution patterns reflects use at all elevations in the subbasin. Further excavation of sites within the 1100 to 1400 m elevation zone should provide more evidence of summer base camps. The high diversity of resources (floral and faunal) available to groups within this zone, and the amount of energy it would take to travel to this elevation, suggest that family groups would choose to stay for more than just short forays. Sites in this elevation zone would be strategically located between the high elevation subalpine plant communities and the low elevations situated along the major river systems. I propose that in the North Santiam subbasin, summer and fall base camp locations should be located in elevation zones 1 (<= 600 m) and 4 (1100 to1400 m). Continued research at sites within each of the elevation zones could help clarity their function and how they may link to other sites in the system. This study is a preliminary look at what types of sites are located in the North Santiam and how they relate to key environmental and social variables. Work is need to uncover how sites function and how they relate to each other, and the surrounding regions. Key problems and methodological needs include continual refinement of the Cascade chronology and functional interpretation of sites through further excavation work or intensive investigation of surface artifacts at sites within the elevations zones. Working with paleo-climatologists can help reveal shifts in plant and animal species and subsequent shifts in human land-use through time. However, Emily Russell (1997), historical ecologist, stresses that it is not just climatic change that affected the ecosystem, but human impacts such as hunting and the use of fire also had an impact. Presently, there is no data on Indian use of fire in the subbasin. Future research in this area could help elucidate human impacts on the ecosystem.

GIS has provided an opportunity to look at human land-use patterns from a regional perspective using a much larger database than was initially used to create the models to be tested. Important in presenting an honest GIS model is ground truthing for the production of map display the gradient of uncertainty in boundary positioning (fuzzy boundary) (Zadeh 1994). A shadow map of certainty can also be produced by assigning probability values as a function of increasing distance from the implied boundary (Berry 1997). This would require taking a GIS map of site locations and other environmentally map variables into the field to determine the accuracy of the GIS mapped features. Further testing and refinement of the model over a long period of time is crucial to successful interpretation of prehistoric land-use patterns in the North Santiam subbasin and the western Cascades in general. Also, it must be recognized that the use of a model does not obviate the need to do field studies prior to ground disturbing projects, but it should prevent considerable damage of archaeological resources in areas likely to contain sites.

While this study has been descriptive in character, it has provided key distributional data on prehistoric sites and their association to particular ecological zones within the North Santiam subbasin, from which a wide variety of inferences have been made. The purpose was to test the current models, define problem areas, and generate new hypotheses. It has contributed to the broader regional study of land-use patterns and should be incorporated in the Willamette National Forests Inventory Plan allowing for better management decisions for the protection of prehistoric sites in the subbasin.

BIBLIOGRAPHY

Agee, James K.
1993 Fire Ecology of Pacific Northwest Forests. Island Press, Washington D.C.

Aikens, C. Melvin
1993 Archaeology of Oregon. U.S. Department of Interior, Bureau of Land Management, Oregon State Office. Second Edition.

Altschul, Jeffrey A.
1988 Models and The Modeling Process, In *Quantifying the Present and Predicting the Past, Theory, Method, and Application of Archaeological Predictive Modeling.* Edited by W. James Judge and Lynne Sebastian, pp 61-96. For the U.S. Department of the Interior, Bureau of Land Management, Denver, Colorado. U.S. Government Printing Office, Washington, D.C. 20402.

Andresfsky, William Jr.
1994 Raw-Material Availability and the Organization of Technology. *American Antiquity, 59(1) pp. 21-34.* Society for American Archaeology.

Baldwin, Ewart M.
1976 Geology of Oregon. Kendall/Hunt Publishing Company. Dubuque, Iowa.

Barnarsky, Cathy W., Patricia M. Anderson and Patrick J. Bartlein
1987 The Northwestern U.S. during Deglaciation; Vegetational History and Paleoclimatic Implications. *The Geology of North America, Vol. K-3, North America and Adjacent Oceans during the Last Deglaciation.* The Geological Society of America.

Barrs, Patricia R.
[1982] Near Neighbors. Cross-Cultural Friendships in Dickey Prairie and South Molalla. Copy in Molalla Historical Society, Molalla, Oregon. Funded by the Oregon Committee for the Humanities.

Basgall, Mark E.
1995 Obsidian Hydration Dating of Early-Holocene Assemblages in the Mojave Desert. Current Research in the Pleistocene. Vol. 12.

Baxter, Paul W.
1986 Archaic Upland Adaptations in the Central Oregon Cascades. Ph.D. Dissertation, Department of Anthropology. University of Oregon. Eugene.

Baxter, Paul W., Richard D. Cheatham,Thomas J. Connolly, and Judith Willig
1983 Rigdon's Horse Pasture Cave: An Upland Hunting Camp in the Western Cascades. University of Oregon Anthropological Papers 28.

Baxter, Paul W. and Thomas J. Connolly
1985 Vine Rockshelter. A Report of the Excavations at An Intermittent Hunting Camp in the Western Cascades. A Report to the Rigdon Ranger District, Willamette National Forest.

Beardsley, Felicia Rounds
1988 Letter Report on the Results of Preliminary Testing of Wagontire Bench (35LIN374) on the Detroit Ranger District, Willamette National Forest.

1990 Shady Cove (35MA49) Archaeological Site Evaluation, Detroit Ranger District, Willamette National Forest. Report on File at the Detroit Ranger District.

Beck, Charlotte
1998 Projectile Point Types as Valid Chronological Units. In *Unit Issues in Archaeology, Measuring Time, Space and Material.* Edited by Ann F, Ramenofsky and Anastasia Steffen. The University of Utah Press, Salt Lake City.

Beck, Charlotte and George T. Jones
1994 Dating Surface Assemblages Using Obsidian Hydration. In *Dating in Exposed and Surface Contexts.* Edited by Charlotte Beck. University of Mexico Press.

2000 Obsidian Hydration Dating, Past and Present. In *It's About Time.* A History of Archaeological Dating in North America.

Beckman, Stephen Dow
1977 The Indians of Western Oregon. This Land Was Theirs. Arago Books, Coos Bay, Oregon.

Bell, James
1982 Report of the Testing and Excavation of the Scarred Doe Archaeological Site (18-04-137). Pacific Crest Research Corporation, Prepared for the Detroit Ranger District, Willamette National Forest.

Bergland, Eric O., Jeffrey C. McAlister, and Christopher Stevenson
1994 An Induced Hydration Rate for Obsidian Cliffs Glass. In *Contributions to the Archaeology of Oregon 1989-1994*, Edited by Paul W. Baxter. Association of Oregon Archaeologists Occasional Papers No. 5.

Berry, Joseph K.
1993 Beyond Mapping: Concepts, Algorithms, and Issues in GIS. GIS World Books, GIS World Inc. Fort Collins, Colorado, USA.

1997 Spatial Reasoning for Effective GIS. GIS World Books, GIS World, Inc. Fort Collins, Colorado, USA.

Binford, Lewis R.
1978 Nunamiut Ethnoarchaeology. Academic Press, New York.

1980 Willow Smoke and Dogs' Tails: Hunter-Gatherer Settlement Systems and Archaeological Site Formation. *Amercian Antiquity, Vol. 4, No.1:4-20.* Society for American Archaeology.

1982 The Archaeology of Place. *Journal of Anthropological Archaeology* 1(1), 5-31.

Boyd, R.
1986 Strategies of Indian Burning in the Willamette Valley. Canadian Journal of Anthropology 5:56-86.

Burke, Constance J.
1979 Historic Fires in the Central Western Cascades, Oregon. A Thesis submitted to Oregon State University.

Burtchard, Greg C.
1990 The Posy Archaeological Project, Upland Use of the Central Cascades; Mt Hood National Forest, Oregon. Cultural Resource Investigation Series Number 3. Report Completed Under Contract to the U.S.D.A. Forest Service, Mt Hood National Forest, Gresham, Oregon.

Burtchard, Greg C. and Robert W. Keeler
1991 Mt Hood Cultural Resource Revaluation Project. A consideration of Prehistoric and Historic Land-Use and Cultural Resource Survey Design and Reevaluation Mt Hood National Forest, Oregon. Report completed Under Contract to the U.S.D.A. Forest Service, Mt Hood National Forest, and Gresham, Oregon.

Burtchard, Greg C., Dennis R. Werth, and Sandra Snyder
1993 Clackamas Wild and Scenic River Cultural Resource Inventory Project. Part I: Narrative Volume. Report Completed Under Contract to the U.S.D.A. Forest Service, Mt. Hood National Forest, Gresham, Oregon.

Butler, B. Robert
1961 The Old Cordilleran Culture in the Pacific Northwest. Occasional Papers of the Idaho State College Museum 5.

Butzer, Karl W.
1982 Archaeology as Human Ecology: Method and Theory for a Contextual Approach Cambridge University Press, Cambridge, London New York, New Rochelle, Melbourne Sydney.

Byram, Scott and Thomas Connolly
1993 Obsidian Hydration Results of Analysis of 45 artifacts from Cascadia Cave, 35LIN11, submitted to Paul Baxter, March 15, 1993.

Campbell, Alcetta Gilbert
1973 Vegetative Ecology of Hunts Cove, Mt Jefferson, Oregon. A Thesis submitted to Oregon State University.

Carmichael, David L.
1988 GIS Predictive Modeling of Prehistoric Site Distributions in Central Montana. In *Interpreting Space: GIS and Archaeology.* Edited by Kathleen M.S. Allen, Stanton W. Green, and Ezra B.W. Zubrow, pp.90-111. Taylor and Francis Press, London, New York, Philadelphia.

Carr, Christopher
1985 For Concordance in Archaeological Analysis. Bridging Data structure, Quantitative Technique and Theory. Westport Publishers, Inc.

Chou, Yue-Hong
1997 Exploring Spatial Analysis in Geographic Information Systems. Onword Press, Santa Fe, New Mexico.

Churchill, Thomas E. and Paul Christy Jenkins
1991 Archaeological Evaluation of the Short Saddle Site. Report Prepared for the Detroit Ranger District, Willamette National Forest. Coastal Magnetic Search and Survey Report No. 53.

Clarke, David L.
1968 Analytical Archaeology. Methuen, London.

Clarke, Keith C.
1997 Getting Started with Geographic Information Systems. Prentice Hall Series in Geographic Information Science. Prentice Hall inc., Upper Saddle River, New Jersey.

Cole, David L.
1968 Archaeology of the Fall Creek Dam Reservoir Area. Report of the Museum of Natural History, University of Oregon, to the National Park Service.

Connolly, Thomas J.
1994 Paleo Point Occurrences in the Willamette Valley, Oregon. In *Contributions to The Archaeology of Oregon 1989-1994.* Association of Oregon Archaeologist Occasional Papers No. 5.

1999 Newberry Crater a Ten-thousand Year Record of Human Occupation and Environmental Change in the Basin-Plateau Borderlands. University of Utah Anthropological Papers Number 121.

Connolly, Thomas J. and P. W. Baxter
1986 New Evidence on a "Traditional" Topic in Pacific Northwest Prehistory. In *Contributions to the Archaeology of Oregon, 1983-1986,* edited by K. H. Ames, pp. 129-146. Occasional Papers No. 3. Association of Oregon Archaeologists, Portland.

Connolly Thomas J. and Richard E. Hughes
1999 Geochemical Characterization of the Newberry Caldera Obsidian Flows. In *Newberry Crater a Ten-thousand Year Record of Human Occupation and Environmental Change in the Basin-Plateau Borderlands.* University of Utah Anthropological Papers Number 121.

Crabtree, Don
1982 An Introduction to Flintworking. Occasional Papers of the Idaho Museum of National History, Number 28k, Second Edition, Pocatello, Idaho.

Dalla Bona, Luke
Predictive Modeling Methodology. Ontario Ministry of Natural Resources, Archaeological Predictive Modeling Program. http://www.pictographics.com/apmp.files/method.htm.

Davis, Carl M.
1988 Cultural Resource Inventory Plan Willamette National Forest. Cultural Resource Management Studies No. 1, On File at the Forest Supervisors Office, Willamette National Forest, Eugene, Oregon.

Davis, Wilbur A., C. Melvin Aikens and Otto E. Hendrickson
1973 Archaeology of Phase III, Little Muddy Creek, Oregon. Report of the Northwest Archaeological Research Institute to the National Park Service.

Dewar, Robert E.
1991 Incorporating Variation in Occupation Span Into Settlement-Pattern Analysis. In *American Antiquity, 56(4), pp 604-620.*

Dimling J. and C. McCain
1996 Willamette National Forest Special Habitat Management Guide. On file at the Willamette National Forest Supervisors Office. Eugene, Oregon.

Draper John A., Eileen M. Adams Draper, and Deborah L. Olsen
1994 The Results of Phase II Testing at the Lundsford Saddle Site (35MA119). Report submitted to the Willamette National Forest, Eugene, Oregon. 4D CRM Report No. 3.

1994b Helicopter Logging and Blowdowns: Phase I Testing at the Rue-Twad, Cara Root, and Brigitte's Bonanza Sites, and Phase II Testing at the Caution Crossing, and Albright and Shiny Sites, Willamette National Forest, Linn County, Oregon. 4D-CRM Project Report No. 7 Prepared for the Willamette National Forest, Eugene, Oregon.

Dunnell, Robert C. and William Dancey
1983 The Siteless Survey: A Regional Scale Data Collection Strategy. In *Advances in Archaeological Method and Theory, Volume 6,* edited by M.B. Schiffer, pp. 267-287. Academic Press, New York.

Eder, James F.
1984 The Impact of Subsistence Change of Mobility and Settlement Pattern in A Tropical Forest Foraging Economy: Some Implications for Archaeology. *The American Anthropological Association 86:837-53.*

Environmental Systems Research Institute, Inc.
1996 ArcView Spatial Analyst, ESRI inc. Press,
ARC Doc Online Help Version 7.1.1.

Fagan John L., David V. Ellis, F. Paul Rushmore, and Douglas C. Wilson
1992 Archaeological Data Recovery Investigations at the Canyon Owl Site (35LIN336). Report submitted to the Willamette National Forest, Eugene, Oregon. Archaeological Investigations Northwest Report No. 20.

Flenniken, J. Jeffrey and Terry L. Ozbun
1990 Archaeological Testing and Evaluation of the Swamp Peak Way Trail One Site, 35LIN373. Lithic Analysis Research Report No. 18. Prepared for the Willamette National Forest.

1994 Toad Archaeological Testing and Evaluation Project (35LIN306, 35LIN307, 35LIN327, 35LIN503, and 35LIN510). Report submitted to the Willamette National Forest, Eugene, Oregon. Lithic Analysts Research Report No. 42.

Flenniken, J. Jeffrey and Terry L. Ozbun, A. Catherine Fulkerson and Carol J. Winkler
1990 The Diamond Lil Deer Kill Site: A Data Recovery Project in the Western Oregon Cascade Mountains. Report submitted to the Willamette National Forest, Eugene, Oregon. Lithic Analysts Research Report No. 11.

Franklin, Jerry F. and C. T. Dyrness
1988 Natural Vegetation of Oregon and Washington. Oregon State University Press.

Friedman, I., and Smith R.L.
1960 A New Dating Method Using Obsidian. Science 191:347-352.

Friedman, I., Trembour, F., Smith, F. and Smith, G.
1994 Obsidian Hydration Dating Affected by Relative humidity? *Quaternary Research 41:185-190.*

Friedman, Irving, Fred W. Trembour, and Richard E. Hughes
1997 Obsidian Hydration Dating. *In Chronometric Dating in Archaeology*. Edited by R.E. Taylor and Martin J. Aitken. Advances in Archaeological and Museum Science, Volume 2. Plenum Press, New York.

Galm, Jerry R. and Stan and Gough
2000 Site 45KT1362: A 10,000 Year B.P. Occupation in Central Washington. Current Research in The Pleistocene.

Griffen, Dennis G.
1985 Prehistoric Utilization of Thermal Springs in the Pacific Northwest. Unpublished M.A.I.S., Oregon State University.

Hasenstab, Robert J. and Benjamin Resnick
1990 GIS in Historic Predictive Modeling: the Forest Drum Project. In *Interpreting Space: GIS and Archaeology*. Edited by Kathleen M.S. Allen, Stanton W. Green, and Ezra B.W. Zubrow, pp.284-306. Taylor and Francis Press, London, New York, Philadelphia.

Heid, James
1987 Packard Creek Site (35LA475): Determination of Eligibility to the National Register of Historic Places. Report on file at he Supervisor's Office, Willamette National Forest.

Hemstrom, Miles A., Sheila E. Logan, and Warren Pavlat
1987 Plant Association and Management Guide. Willamette National Forest. United States Department of Agriculture, Forest Service. Pacific Northwest Region.

Henn, Winfield
1975 The Indian Ridge Site, Lane County, Oregon. In Archaeological Studies int eh Willamette Valley, Oregon. Edited by C. Melvin Aikens. University of Oregon Anthropological Papers 8:544-468.

Higgs, E.S.
1972 Paleoeconomy. London and New York: Cambridge University Press.

Higgs, E.S. and C. Vita-Finzi
1972 Prehistoric Economies: A territorial Approach. In *Papers in Economic Prehistory*. Cambridge University Press. London and New York.

Hughes, Richard E.
1986 Energy Dispersive X-Ray Fluorescence Analysis of Obsidian From Dog Hill and Burns Butte, Oregon. *Northwest Science 60 (2) pp. 73-80.*

1986b X-ray Fluorescence Analysis of Artifacts from Rigdon and Detroit Ranger District, Willamette National Forest, Oregon. Letter report submitted to James Heid, Forest Archaeologist, Willamette Naitonal Forest, November 25, 1986.

1988 X-ray Fluorescence results, Letter Report to Carl Davis (Willamette National Forest Eugene, Oregon). Presenting X-Ray Fluorescence Results for 155 artifacts on the Detroit, Sweet Home and Oakridge Ranger Districts, Willamette National Forest.

1988b X-ray Fluorescence Results, Letter Report to Elena Nilsson presenting x-ray Fluorescence Data from the Analysis of Artifacts from Sites 35LIN301, on the Detroit Ranger District, Willamette National Forest, April 11, 1998.

1988c X-ray Fluorescence Results, Letter Report to Lee Spencer presenting x-ray Fluorescence Data from the Analysis of Artifacts from Site 35LIN302, on the Detroit Ranger District, Willamette National Forest, October 30, 1988.

1989 X-ray Fluorescence results, Letter Report to Carl Davis (Willamette National Forest Eugene, Oregon). Presenting X-Ray Fluorescence Data Generated from the analysis of Obsidian Source Samples and artifacts from Brinton Creek (Grizzly Creek), Wagontire Site (Detroit) and Upper Salt Creek (Oakridge) and Sweet Home, Willamette National Forest, January 24, 1989.

1990 Obsidian Source Determination for The Posy Archaeological Project (35CL21 and 35CL22). In *The Posy Archaeological Project, Upland Use of the Central Cascades; Mt Hood National Forest, Oregon by Greg Burtchard.*

1991 X-ray Fluorescence Results, Letter Report to Thomas E. Churchill of Artifacts from Site 35MA22 on the Detroit Ranger District, Willamette National Forest, April 4, 1991.

1993 X-ray Fluorescence Results, Letter Report to John A. Draper (4-D CRM) of Artifacts from Sites 35MA119 on the Detroit Ranger District, Willamette National Forest, March 13, 1993.

1993b X-ray Fluorescence Results, Letter Report to John A. Draper (4-D CRM) of Artifacts from Sites 18-04-354, 18-04-299, 35LIN525, and 35LIN515 on the Detroit Ranger District, Willamette National Forest, December 20, 1993.

1994 X-ray Fluorescence Results, Letter Report to John W. Dougherty of Artifacts from Sites 35LIN104, 35LIN105, 35LIN107, 35LIN321, and 35LIN396 on the Detroit Ranger District, Willamette National Forest, April 12, 1994.

1999 X-ray Fluorescence Results, Letter Report to Cara Kelly, Detroit Ranger District, Willamette National Forest Presenting results for 31 artifacts from the Detroit Ranger District, September 8, 1999.

2000 X-ray Fluorescence Results, Letter Report to Cara Kelly, Detroit Ranger District, Willamette National Forest, Presenting results for 29 artifacts from the Detroit Ranger District, September 21, 2000.

Hughes, Richard E. and Thomas J. Connolly
1999 Distribution of Newberry Calder Obsidians. *In Newberry Crater a Ten-thousand Year Record of Human Occupation and Environmental Change in the Basin-Plateau Borderlands*. University of Utah Anthropological Papers Number 121.

Jackson, Robert J.
1984 Obsidian Hydration: Applications in the Western Great Basin. In *Contributions of the University of California Archaeological Research Facility Vo. 45.*

Jackson, Robert J. and Tad E. Allred
1994 Obsidian Hydration Analysis Results, Letter Report for Artifacts from Sites 35LIN105, 35LIN107, 35LIN321, 35LIN321, 35LIN396, 40152, 40152, 40153 on the Detroit Ranger District, Willamette National Forest, May 19, 1994.

Jackson, Thomas L., and Robert J. Jackson
1991 Letter Report to John Fagan of X-ray Fluorescence Analysis and Obsidian Hydration Rim Measurement of Artifact Obsidian from site 35LIN336, October 9,1991.

Jackson, Thomas L., M. Kathleen Davis, Jay H. King
1994 Letter Report to John A. Draper of X-ray Fluorescence Analysis and Obsidian Hydration Rim Measurement of Artifact Obsidian from 35GR250, 35LIN515, and 18-04-299, January 25, 1994.

Jarman, M.R., C. Vita-Finzi, and E. S. Higgs
1972 Site Catchment Analysis in Archaeology. In *Man, Settlement and Urbanism.* Edited by Peter J. Ucko, Ruth Tringham and G.W. Dimbleby. Cambridge, Mass: Schenkman PG 61-66.

Jenkins, Paul Christy
1988 Archaeological Evaluation of the Saddle Quarry Site (35MA68) Report Prepared for the Detroit Ranger District, Willamette National Forest.

Jenkins, Paul Christy and Thomas E. Churchill
1984 An Archaeological Evaluation of the Fox Bug Site, 35MA48. Coastal Magnetic Search and Survey Report 3. Gresham, Oregon.

1987 Archaeological Testing of the North Park Headwaters and North Park Salvage Sites, Sweet Home Ranger District Willamette National Forest. Survey Report No. 22.

Jochim, Michael J.
1976 Hunter-Gatherer Subsistence and Settlement, A predictive Model. Academic Press: New York.

Johnson, Oscar
1998 The Molalla Tribe: A Nation of Good Hunters. In the *Grande Ronde Review,* A Publication of the Grand Ronde Tribe, Umpqua, Molalla, Rogue River, Kalapuya and Chasta. September 1, 1998.

Jones George T. and Charlotte Beck
1990 An Obsidian Hydration Chronology of Late Pleistocene-Early Holocene Surface Assemblages from Butte Valley, Nevada. *Journal of California and Great Basin Anthropology Vol. 12, No. 1 pp. 84-100.*

Kelly, Robert L.
1992 Mobility/Sedentism: Concepts, Archaeological measures, and Effects. *Annual Review of Anthropology. 21:43-66.*

1993 Hunter-Gatherer Mobility Strategies. *Journal of Anthropological Research, pp 277-306.*

Kohler, Timothey A.
1988 Predictive Locational Modeling: History and Current Practice. In *Quantifying the Present and Predicting the Past, Theory, Method, and Application of Archaeological Predictive Modeling.* Edited by W. James Judge and Lynne Sebastian, pp 19-53. For the U.S. Department of the Interior, Bureau of Land Management, Denver, Colorado. U.S. Government Printing Office, Washington, D.C. 20402.

Kvamme, Kenneth L.
1985 Determining Empirical Relationships between the Natural Environment and Prehistoric Site Locations: A Hunter-Gatherer Example. In, *Concordance in Archaeological Analysis, Bridging Data Structure, Quantitative Technique, and Theory,* edited by C. Carr; Westport Publisher, Kansas City, Mo. Pp. 208-238.

1988 Using Existing Archaeological Survey Data for Model Building. In *Quantifying the Present and Predicting the Past, Theory, Method, and Application of Archaeological Predictive Modeling.* Edited by W. James Judge and Lynne Sebastian, pp 301-322. For the U.S. Department of the Interior, Bureau of Land Management, Denver, Colorado. U.S. Government Printing Office, Washington, D.C. 20402

1989 Geographic Information Systems in Regional Archaeological Research and Data Management. In *Archaeological Method and Theory, Volume 1*, edited by M.B. Schiffer, pp. 139-202. University of Arizona Press, Tucson.

1990 GIS Algorithms and Their Effects on Regional Archaeological Analysis. In *Interpreting Space: GIS and Archaeology*. Edited by Kathleen M.S. Allen, Stanton W. Green, and Ezra B.W. Zubrow, pp.112-125. Taylor and Francis Press, London, New York, Philadelphia.

Kvamme, Kenneth L. and Timothy A. Kohler
1988 Geographic Information Systems: Technical Aids, for Data Collection, Analysis, and Display. In *Quantifying the Present and Predicting* the Past, Theory, Method, and Application of Archaeological Predictive Modeling. Edited by W. James Judge and Lynne Sebastian, pp. 493-543. For the U.S. Department of the Interior, Bureau of Land Management, Denver, Colorado. U.S. Government Printing Office, Washington, D.C. 20402

Leach, David
1995 Silviculture Report, *In The Upper North Santiam Watershed Analysis*, Detroit Ranger District, Willamette National Forest.

Lebow, Clayton G.
1984 Archaeological Investigation at the Ripple Site (35CL55) in the Mt. Hood National Forest, Clackamas County, Oregon. Department of Anthropology, Oregon State University. Prepared for the Mt. Hood National, Oregon.

Leonhardy, Frank C., and David G. Rice
1970 A Proposed Culture Typology for the Lower Snake River Region, Southeastern Washington. *Northwest Anthropological Research Notes 4: 1-29.*

Lindberg-Muir, Catherine
1983 Archaeological Test of the Horn Ridge Archaeological Site (35LIN252), Detroit Ranger District, Willamette National Forest.

1989 Obsidian: Archaeological Implications for the Central Oregon Cascades. Unpublished M.A.I.S. Thesis, Department of Anthropology, Oregon State University, Corvallis.

Lock, Gary and Zoran Stancic
1995 Archaeology and Geographical Information Systems. Taylor and Francis.

Mackey, Harold
1974 The Kalapuyans. A Sourcebook on the Indians of the Willamette Valley. Published in cooperation with Mission Mill Museum Association, Inc. Salem, Oregon.

Marozas, Bryan A. and James A. Zack
1990 GIS and Archaeological Site Location. In *Interpreting Space: GIS and Archaeology*. Edited by Kathleen M.S. Allen, Stanton W. Green, and Ezra B.W. Zubrow, pp.165-172. Taylor and Francis Press, London, New York, Philadelphia.

Mazer, J.J., C.M. Stevenson, W.L. Ebert, and J.K. Bates
1991 The Experimental Hydration of Obsidian as a Function of Relative Humidity and Temperature. *American Antiquity, 56 (3) pp. 504-513.*

McAlister, Jeff
1993 Oracle Cultural Resource Database User Manual. USDA Forest Service, Pacific Northwest Region, Willamette National Forest, Eugene, Oregon.

Miller, Eric A. and Halpern, Charles B.
1998 Effects of Environment and Grazing Disturbance on Tree Establishment in Meadows of the Central Cascade Range, Oregon, USA. In *Journal of Vegetation Science 9:265-282.*

Minor, Rick
1987 Cultural Resource Overview of the Willamette National Forest: A 10-Year Update. Heritage Research Associates Report No. 60. Report to the Willamette National Forest, Eugene, Oregon.

Minor, Rick, Stephen Dow Beckham, and Kathryn Anne Toepel
1981 Prehistory and History of the Upper Willamette Valley, Oregon: Research Questions and Approaches. Report submitted to the U.S. Army Corps of Engineers, Portland, Oregon. Heritage Research Associates Report No. 9, Eugene, Oregon.

Minor, Rick and Audrey Frances Pecor
1977 Cultural Resource Overview of the Willamette National Forest Western Oregon. Report submitted to the Willamette National Forest, Eugene, Oregon. University of Oregon Anthropological Papers No. 12.

Minor, Rick and Kathryn Anne Toepel
1981 Archaeology Overview. *In Prehistory and History of BLM Lands in West-Central Oregon: A Cultural Resource Overview*, by Stephen Dow Beckham, Rick Minor, and Kathyrn Anne Toepel. University of Oregon Anthropological Papers 25:117-183.

1984 The Blitz Site: an Early-Middle Archaic Campsite in the Cascades of Western Oregon. Heritage Research Associated Report No. 34. Eugene, Oregon.

Morrison, Peter H. and Frederick J. Swanson
1987 Fire History in the Forest Ecosystems of the Central Western Cascade Range, Oregon.

Newman, Jay R.
1994 The Effects of Distance on Lithic Material Reduction Technology. Journal of Field Archaeology 21(4) pp. 491-501. Boston University.

Newman, Thomas M.
1966 Cascadia Cave. Occasional Papers of the Idaho Sate University Museum, 18.

Nilsson, Elena
1989 Archaeological Data Recovery Investigations at the Bear Saddle Site, 35LIN301, Willamette National Forest, Oregon. Prepared For Willamette National Forest, Oregon.

Olsen, Thomas L.
1975 Baby Rock Shelter. In *Archaeological Studies in the Willamette Valley, Oregon.* Edited by C.Melvin Aikens, University of Oregon. Anthropological Papers. No. 8, 1975.

Origer, Thomas M.
1988 Obsidian Hydration Analysis Results, Letter Report to Elena Nilsson for Artifacts from Site 35LIN301 on the Detroit Ranger District, Willamette National Forest, July 30, 1988.

1988b Obsidian Hydration Analysis Results, Letter Report to Lee Spencer for Artifacts from Site 35LIN302 on the Detroit Ranger District, Willamette National Forest, November 19, 1988.

1990 Obsidian Hydration Analysis for the Posy Archaeological Project. In *The Posy Archaeological Project, Upland Use of the Central Cascades; Mt Hood National Forest, Oregon by Greg Burtchard.*

1991 Obsidian Hydration Analysis Results, Letter Report to Tom Churchill for Artifacts from Site 35MA22 on the Detroit Ranger District, Willamette National Forest, April 18, 1991.

1993 Obsidian Hydration Analysis Results, Letter Report to John A. Draper for Artifacts from Site 35MA119 on the Detroit Ranger District, Willamette National Forest, April 8, 1993.

1999 Obsidian Hydration Analysis Results, Letter Report to Cara Kelly presenting the results of hydration analysis on Artifacts from the Detroit Ranger District, Willamette National Forest, October 5, 1999.

2000 Obsidian Hydration Analysis Results, Letter Report to Cara Kelly presenting the results of hydration analysis on Artifacts from the Detroit Ranger District, Willamette National Forest, October 20, 2000.

Origer, Thomas M., T.L. Jackson, M.K. Davis, and J.H. King
1994 Letter report presenting Obsidian Hydration and X-ray Fluorescence Analysis Results for artifacts from Sites 35LIN515 and 18-04-299, on the Detroit Ranger District, Willamette National Forest, January 25, 1994.

Origer, Thomas and Wickstrom
1982 The Use of Hydration Measurements to Date Obsidian Materials from Sonoma County, California. *Journal of California and Great Basin Anthropology 4:123-131.*

Ormsby, Tim and Jonell Alvi
1999 Extending ArcView GIS. Environmental Systems Research Institute, Inc. (ESRI) Press, Redlands, California.

Parker, Sandra
1985 Predictive Modeling of Site Settlement Systems Using Multivariate Logistics. In, *Concordance in Archaeological Analysis, Bridging Data Structure, Quantitative Technique, and Theory,* edited by C. Carr; Westport Publisher, Kansas City, Mo.pp. 208-238.

Parsons, Jeffrey
1972 Archaeological Settlement Patterns. *Annual Review of Anthropology 1:127-150.*

Peck, Dallas L., Allan B. Griggs, Herbert G. Schlicker, Francis G. Wells, and Hollis M. Dole
1964 Geology of Central and Northern Parts of the Western Cascade Range in Oregon. Geological Survey Professional Paper 449. United States Government Printing Office, Washington.

Plog, S., F. Plog, and W. Wait
1978 Decision Making in Modern Surveys. *In Advances in Archaeological Method and Theory, Volume 1.* Edited by M.B. Schiffer, pp 383-421. Academic Press, New York.

Raymond, Anan W.
1986 Flaked Stone Technology at the East Bug-A-Boo Site (35LIN200), Linn County, Oregon. On File at the Detroit Ranger District, Willamette National Forest.

Renfrew, Colin
1977 Alternative Models for Exchange and Spatial Distribution. *In Exchange Systems In Prehistory.* Edited by Timothy K. Earle and Jonathon E. Ericson. Academic Press, New York, San Francisco and London.

Robbins, William G.
1997 Landscapes of Promise, The Oregon Story 1800-1940. University of Washington Press, Seattle and London.

Rose, Martin R. and Jeffrey H. Altschul
1988 An Overview of Statistical Method and Theory for Quantitative Model Building, *In Quantifying the Present and Predicting* the Past, Theory, Method, and Application of Archaeological Predictive Modeling. Edited by W. James Judge and Lynne Sebastian, pp. 173-256. For the U.S. Department of the Interior, Bureau of Land Management, Denver, Colorado. U.S. Government Printing Office, Washington, D.C. 20402.

Russell, Emily W.B.
1997 People and the Land Through Time. Linking Ecology and History. Yale University Press, New Haven and London.

Schermer and Tiffany
1985 Environmental Variables as Factors in Site Location: An Example from the Upper Midwest. *Midcontinental Journal of Archaeology 10(2): 215-240.*

Schiffer, Michael B.
1987 Formation Processes of the Archaeological Record. University of Utah Press, Salt Lake City.

Sea, Debra S. and Cathy Whitlock
1994 Postglacial Vegetation and Climate of the Cascade Range, Central Oregon. In *Quaternary Research 43:370-381.*

Sebastian, Lynne and W. James Judge
1988 Predicting the Past: Correlation, Explanation, and the Use of Archaeological Models. In *Quantifying the Present and Predicting the Past, Theory, Method, and Application of Archaeological Predictive Modeling.* Edited by W. James Judge and Lynne Sebastian, pp. 1-18. For the U.S. Department of the Interior, Bureau of Land Management, Denver, Colorado. U.S. Government Printing Office, Washington, D.C. 20402

Shank, Douglas
1997 Soils and Geology Report, *In Detroit Tributaries Watershed, Willamette Basin.* On File at Detroit Ranger District, Willamette National Forest.

Sharer, Robert J. and Wendy Ashmore
1993 Archaeology Discovering Our Past. Second Edition; Mayfield Publishing Company, Mountain View, California; London; Toronto.

Skinner, Craig E.
1986 The Occurrence, Characterization, and Prehistoric Utilization of Geologic Sources of Obsidian in Central Western Oregon: Preliminary Research Results. MS. On file, Oregon State Museum of Anthropology, University of Oregon. Eugene.

1997 Geoarchaeological and Geochemical Investigations of the Devil Point Obsidian Source, Willamette National Forest, Western Cascades, Oregon. Northwest Research Obsidian Studies Laboratory Report 95-52 prepared for the Willamette National Forest Eugene, Oregon.

Skinner, Craig and Thomas J. Connelly
1999 Instrumental Neutron Activation Analysis. In *Newberry Crater, A Ten-Thousand-Year Record of Human Occupation and Environmental Change in the Basin-Plateau Borderlands*, Thomas Connolly.

Skinner, Craig E., Jennifer J. Thatcher, and M. Kathleen Davis.
1997 X-Ray Fluorescence Analysis and Obsidian Hydration Measurement of Artifact Obsidian from 35-MA-66, Marion County, Oregon. Northwest Research Obsidian Studies Laboratory Report 97-54 prepared for the Willamette National Forest, Eugene, Oregon.

Skinner, Craig E., Jennifer J. Thatcher, and M. Kathleen Davis.
1997b X-Ray Fluorescence Analysis and Obsidian Hydration Rim Measurement of Artifact Obsidian from 35-DS-193 and 35-DS-201, Surveyor Fire Rehabilitation Project, Deschutes National Forest, Oregon. Northwest Research Laboratory, Corvallis, Oregon, Report 98-66.

Skinner, Craig E. and Carol J. Winkler
1994 Prehistoric Trans-Cascade Procurement of Obsidian in Western Oregon: The Geochemical Evidence. In *Current Archaeological Happenings in Oregon 16(2): 3-9.*

Smith, Robin, C.Winkler, T.Ozbun, and J.Fagan
In draftArchaeological Investigations at the Oak Grove Site (35LA912), Middle Fork Ranger District, Willamette National Forest.

Snyder, Sandra Lee
1987 Prehistoric Land Use Patterns in the Central Oregon Cascade Range. Unpublished Dissertation. Department of Anthropology, University of Oregon.

1990 Archaeological Background to the Clackamas Drainage and Adjacent Central Cascade Areas. In *The Posy Archaeological Project, Upland Use of the Central Cascades; Mt Hood National Forest, Oregon. Cultural Resource Investigation Series Number 3*. Edited by Greg C. Burtchard. Report Completed Under Contract to the U.S.D.A. Forest Service, Mt Hood National Forest, Gresham, Oregon.

1991 Site Location Analysis in the Central Oregon Cascade Range. *Northwest Anthropological Research Notes 25 (1): 117-137.*

South, Barry
1999 Lithic Resource Procurement at Obsidian Cliffs, Oregon: A Comparative Study. Unpublished M.A. Thesis, Western Washington University.

Spencer, Lee
1989 Archeological Testing of the Bee Bee Site 35LIN302, A Low Density Site on the Detroit Ranger District, Willamette National Forest.

Stern, Theodore
1998 Klamath and Modoc. *In Handbook of North American Indians. Volume 12 Plateau*. General Editor William C. Sturtevant. Smithsonian Institution, Washington.

Stevenson, Christopher, James J. Mazer, and Barry E. Scheetz
1998 Laboratory Obsidian Hydration Rates: Theory, Method, and Application. *In Advances in Archaeological and Museum Science. Archaeological Obsidian Studies, Method and Theory.* Edited by M. Steven Shackel.

1996 Advances in the Hydration Dating of New Zealand Obsidian. Journal of Archaeological Science 23, 233-242.

Stevenson, Christopher M. Peter J. Sheppard, Douglas G. Sutton and Wallace Ambrose
1993 Homogeneity of Water Content in Obsidian from the Coso Volcanic Field: Implications for Obsidian Hydration Dating.

Steward, Julien
1963 Theory of Culture Change, the Methodology of Multilinear Evolution. University of Illinois Press Urbana.

Sudan, Elmar
1937 Indian Affairs of the Late Eighteenth and Early Nineteenth Centuries, Camp Cascadia Commond, November 16, 1937.

Sullivan III, Alan P.
1992 Investigating the Archaeological Consequences of Short-Duration Occupations. In *American Antiquity, 57(1), 1992, pp.99-115.*

Sutton, Kenneth George
1974 Geology of Mt. Jefferson. Unpublished Master Thesis, University of Oregon.

Swift, Mark
1986 Report on Dead Horse Rockshelter Testings '83-85':35LA656. Report of the Department of Anthropology, University of Oregon, to the Willamette National Forest.

Teensma, Peter Dominic Adrian
1987 Fire History and Fire Regimes of the Central Western Cascades of Oregon. An Unpublished Dissertation, University of Oregon.

Thatcher, Jennifer
2001 The Distribution of Geologic and Artifact Obsidian from the Silver Lake/Sycan Marsh Geochemical Source Group, South-Central Oregon. Unpublished M.A.I.S., Oregon State University.

Toepel, Katheryn Anne
1987 Ethnographic Background. *In Cultural Resource Overview of the Willamette National Forest: A 10-Year Update, Rick Minor et al. (eds).* Heritage Research Associates Report No. 60. Eugene, Oregon.

Trigger, Bruce G.
1989 A History of Archaeological Thought. Cambridge University Press.

Trigger, Bruce G. and William R. Swagerty
1996 Entertaining Strangers: North America in the Sixteenth Century. *In The Cambridge History of The Native Peoples of the Americas. Volume I: North America.*

Vernon, Stivers
1934 Saga of the Skyline Trail Recited. Nomadic Indians First Traveled Over 200-Mile Route on the Roof of the Cascades. *The Sunday Oregonian, Portland (July 1, 1934)*

Vita-Finzi, C., and E. S. Higgs
1970 Prehistoric Economy in the Mount Carmel area of Palestine: Site Catchment Analysis. *Proceedings of the Prehistoric Society* 36:1-37.

Warren, Robert E.
1990 Predictive Modeling of Archaeological Site Location: A case study in the Midwest. In *Interpreting Space: GIS and Archaeology.* Edited by Kathleen M.S. Allen, Stanton W. Green, and Ezra B.W. Zubrow, pp.201-215. Taylor and Francis Press, London, New York, Philadelphia.

Werner, Roger H., John W. Dougherty, Thomas B. Anderson and Jeff Parsons
1998 Bruno Meadows Archaeological Site Evaluation. Archaeological Services Inc. Stockton, California. Report prepared for Willamette National Forest, Eugene, Oregon.

White, John R.
1975 A Proposed Typology of Willamette Valley Sites. *In Archaeological Studies in the Willamette Valley, Oregon.* Edited by C.Melvin Aikens, University of Oregon. Anthropological Papers. No. 8, 1975.

1975b The Hurd Site. *In Archaeological Studies in the Willamette Valley, Oregon.* Edited by C.Melvin Aikens, University of Oregon. Anthropological Papers. No. 8, 1975.

Winkler, Carol
1984 A Site Location Analysis for the Middle Fork of the Willamette River Watershed. Unpublished M.A., Department of Anthropology, University of Oregon.

1991 The Middle Fork Willamette River Corridor as Trans-Cascade Travel Route: the Evidence from Obsidian Sourcing. Paper written for the Willamette National Forest. Presented at the Northwest Anthropological Conference Missoula Montana.

Winthrop, K. D. Gray
1984 Archaeological Data Recovery Program: Hugh Creek Site, 35CL61, Clackamas County, Oregon. Winthrop and Winthrop Consulting Anthropologists. Ashland, Oregon.

Woodward, John A.
1972 The Geertz Site: An Early Campsite in Western Oregon. *Tebiwa 15(2): 55-62.*

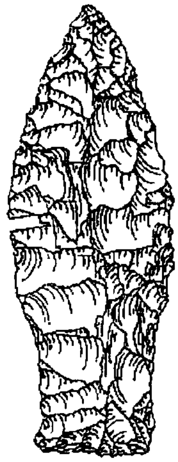
Zadeh, Lotfi A.
1994 Fuzzy Logic Can Help GIS Cope With Reality. *GIS World, Inc. September.*

Zenk, Henry B. and Bruce Rigsby
1998 Molala. *In Handbook of North American Indians. Volume 12 Plateau.* General Editor William C. Sturtevant. Smithsonian Institution, Washington.

APPENDICES

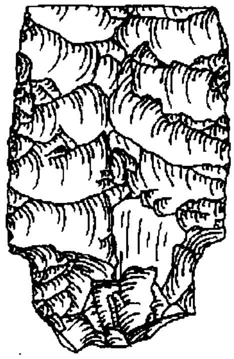
Appendix A
Artifact Illustrations

Figure 49: Western Stemmed Projectile Points, Fragments, and Punches from the North Santiam Subbasin.

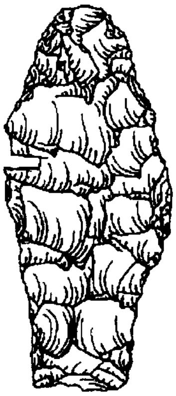


4-2054

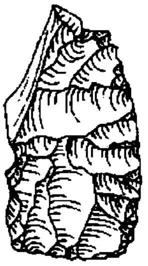
4-3068



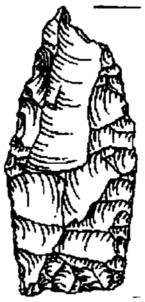
4-204



4-01

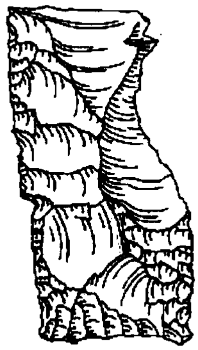


4-2065

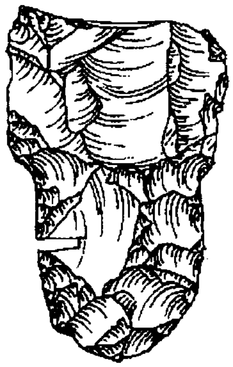


4-3121

4-2243



4-3071



4-24

Figure 50: Western Stemmed Base Fragments from the North Santiam Subbasin.

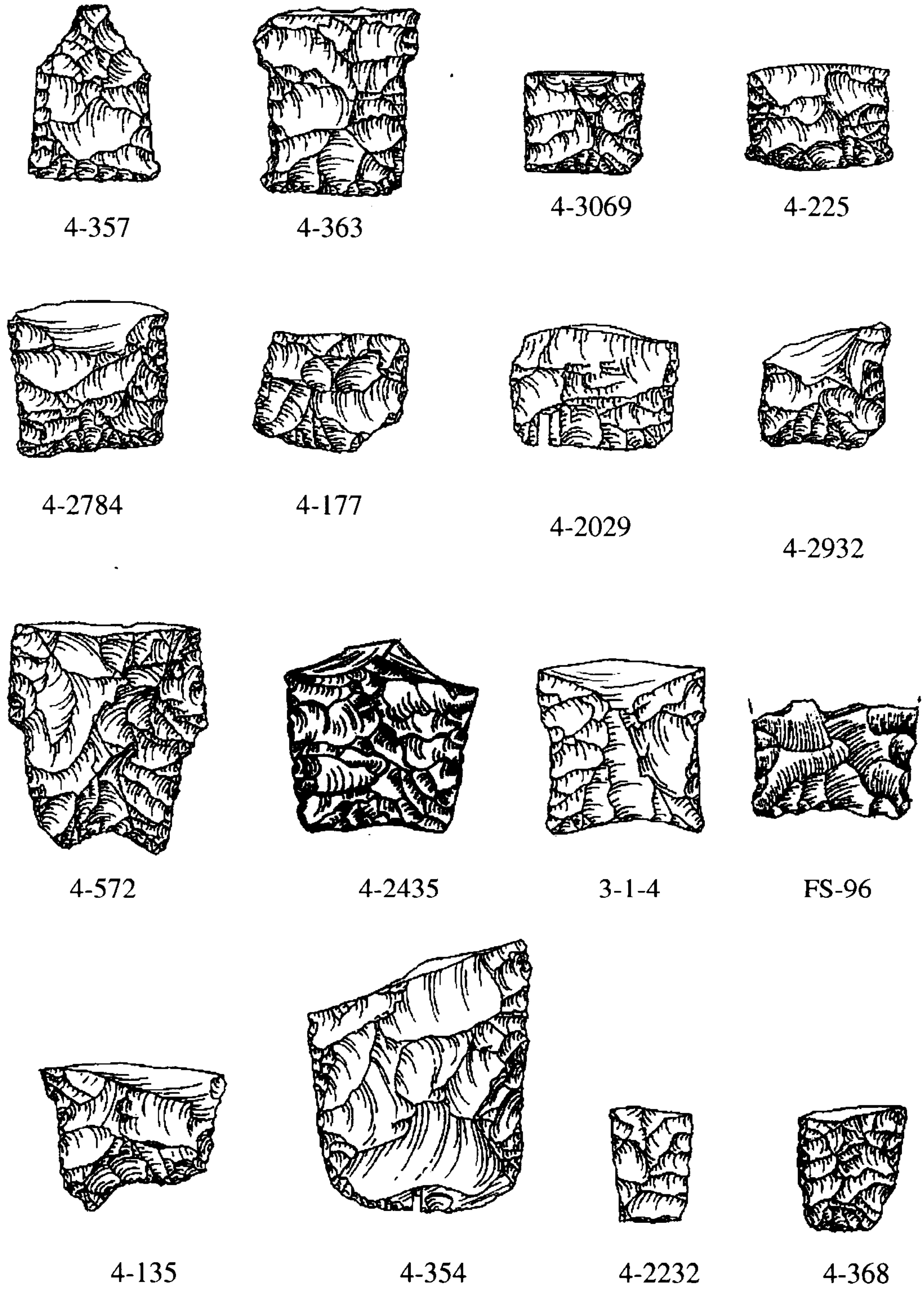


Figure 51: Foliate Points from the North Santiam Subbasin.

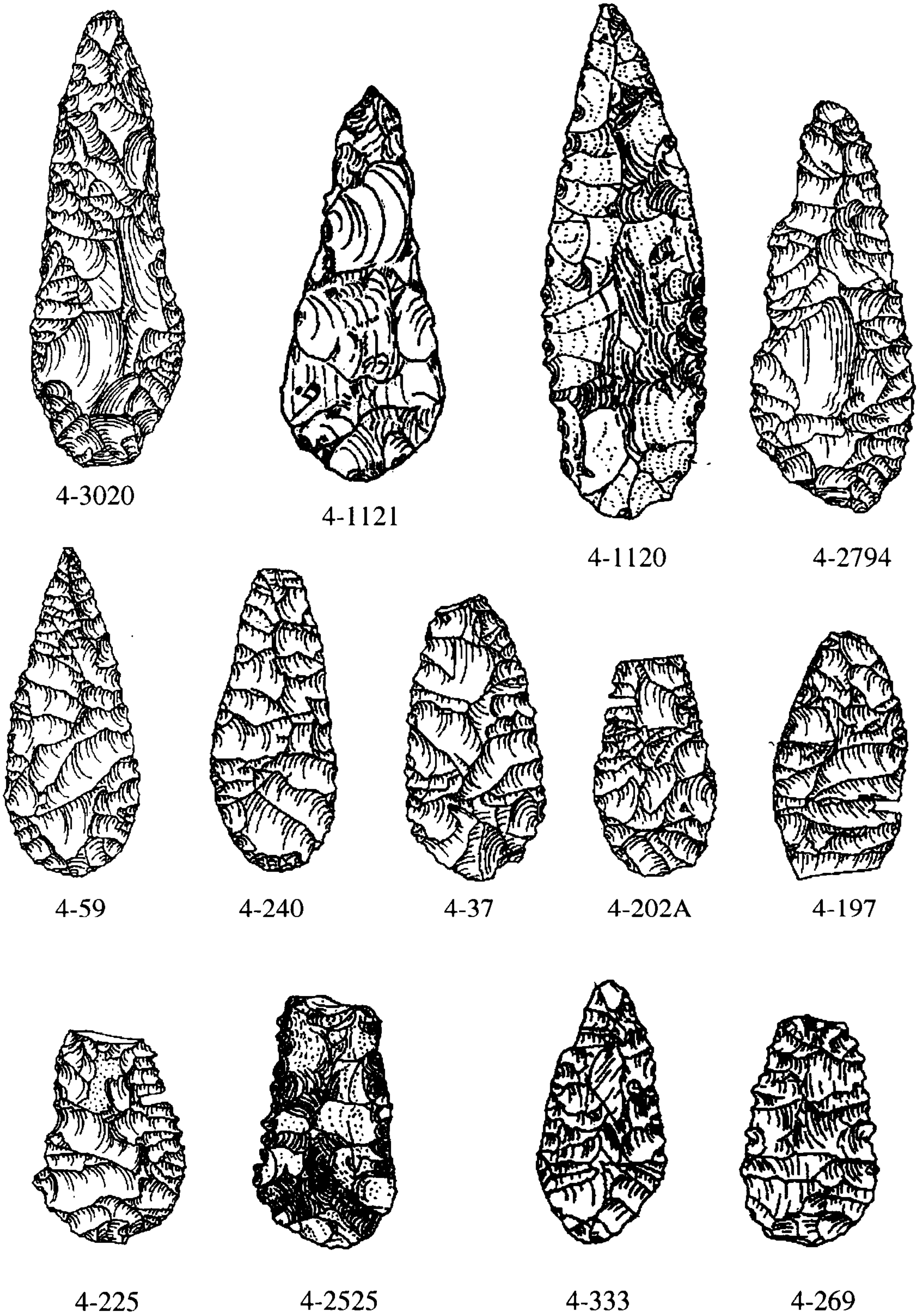


Figure 52: Foliate Points from the North Santaim Subbasin.

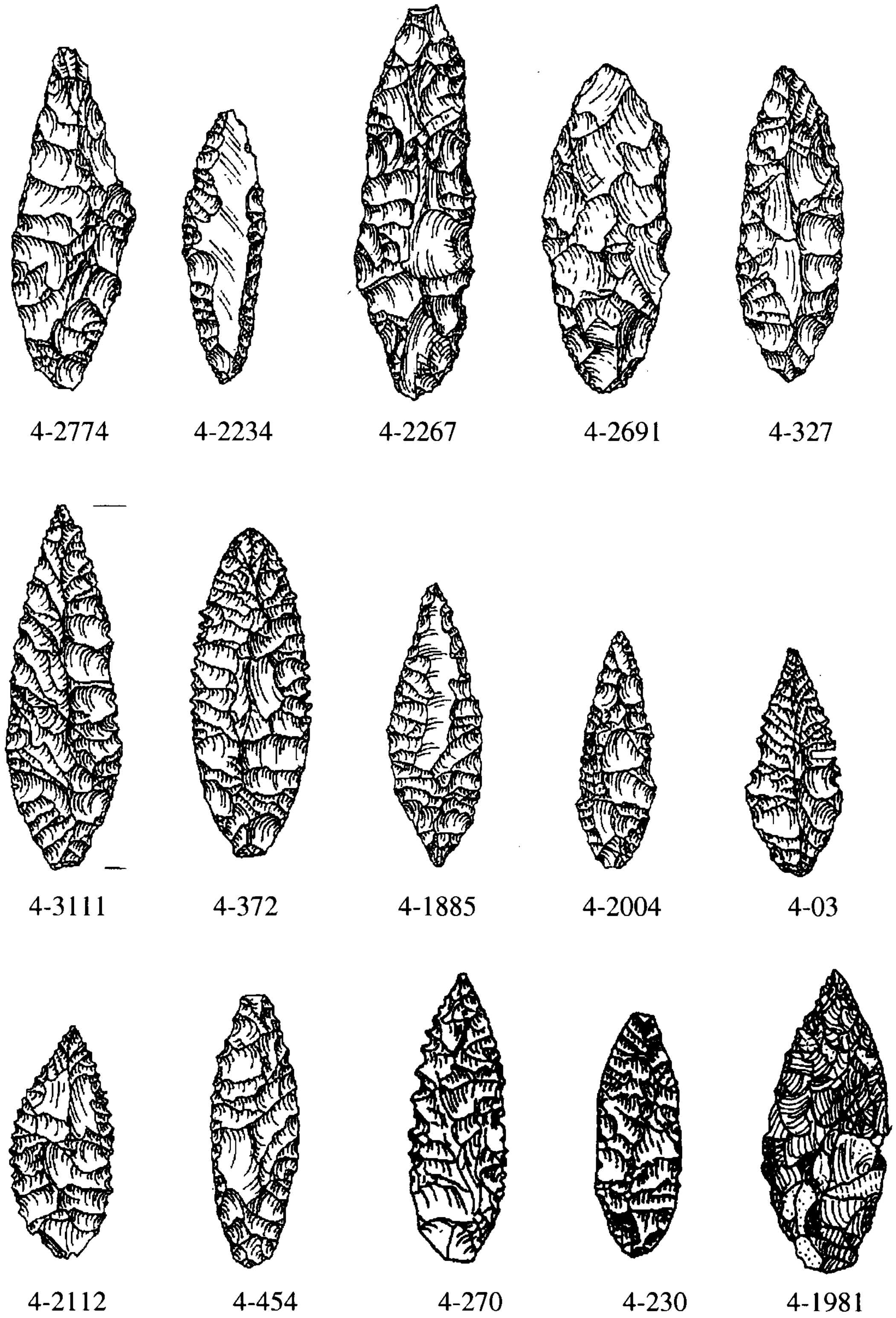


Figure 53: Foliate Points From the North Santiam Subbasin.

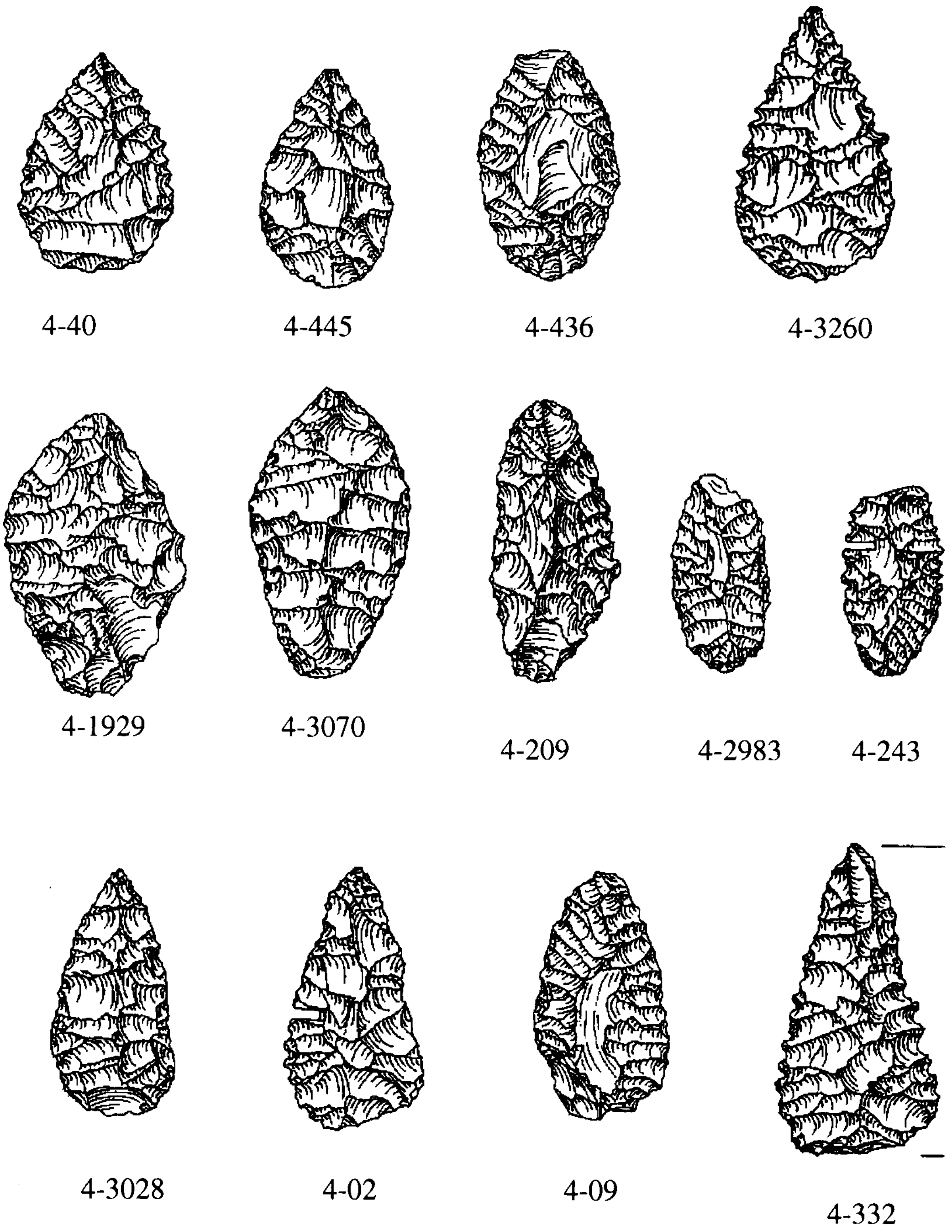


Figure 54: Foliate Points from the North Santiam Subbasin.

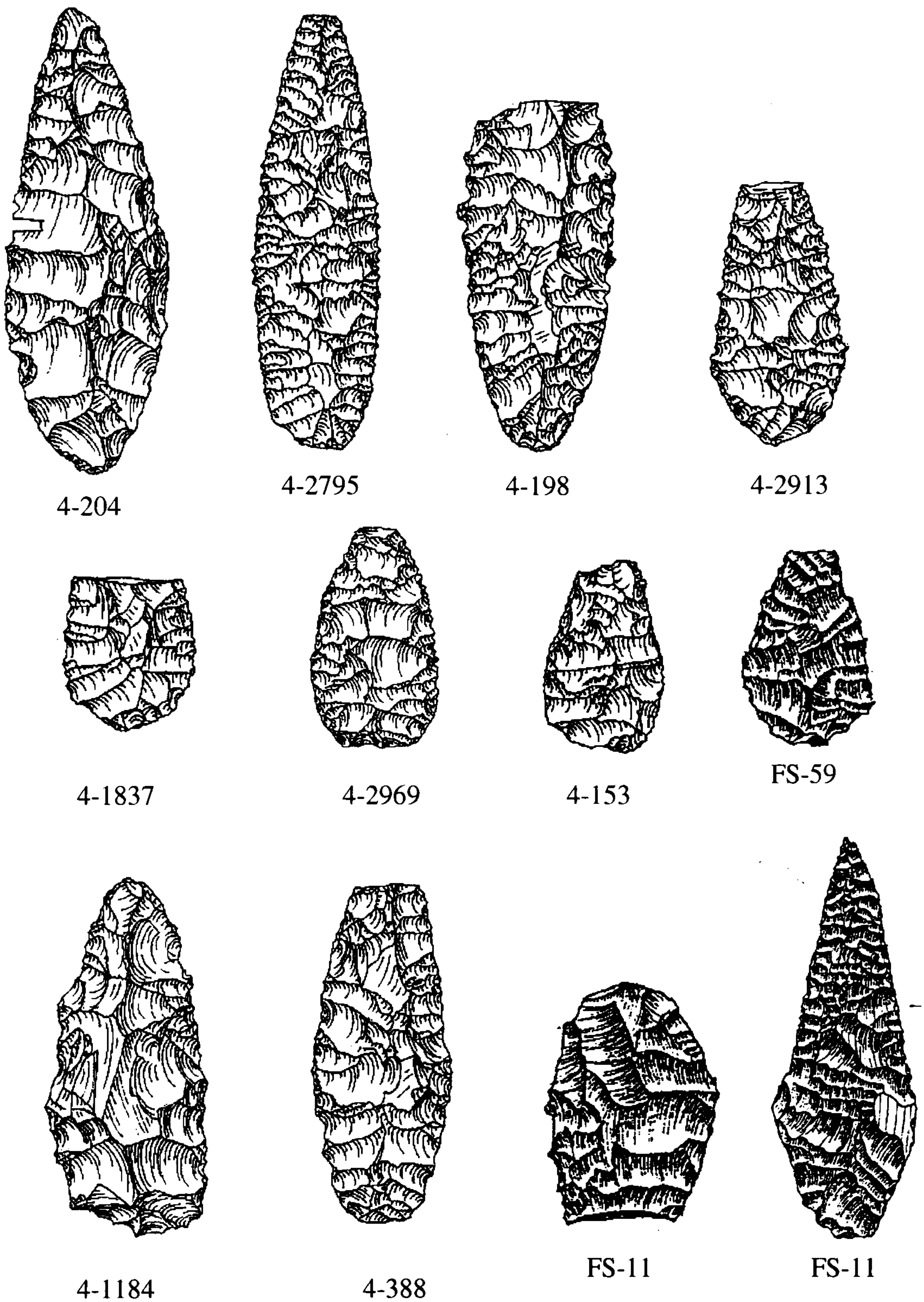


Figure 55: Foliate Point Fragments from the North Santiam Subbasin.

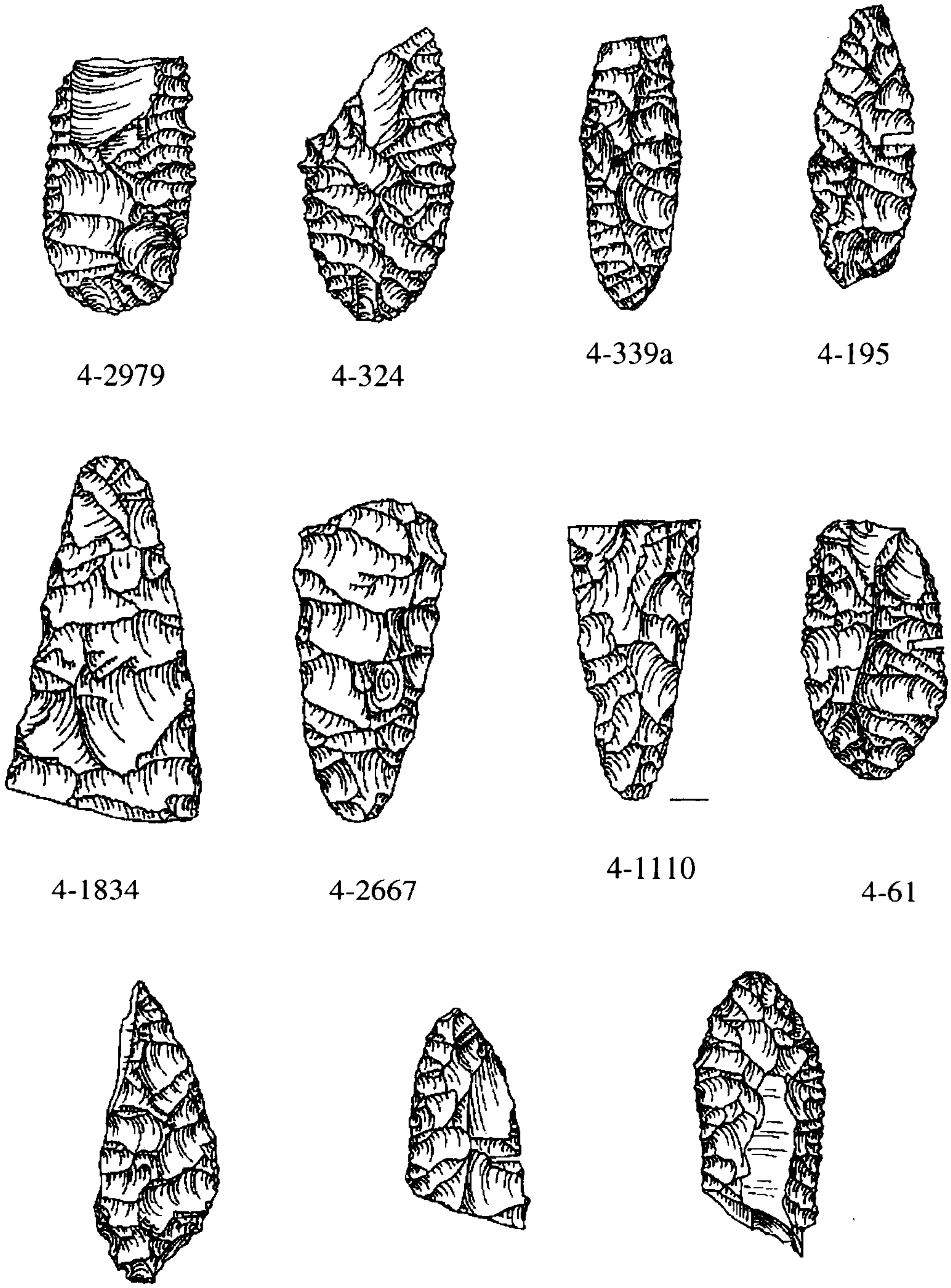


Figure 56: Dart Points From the North Santiam Subbasin.

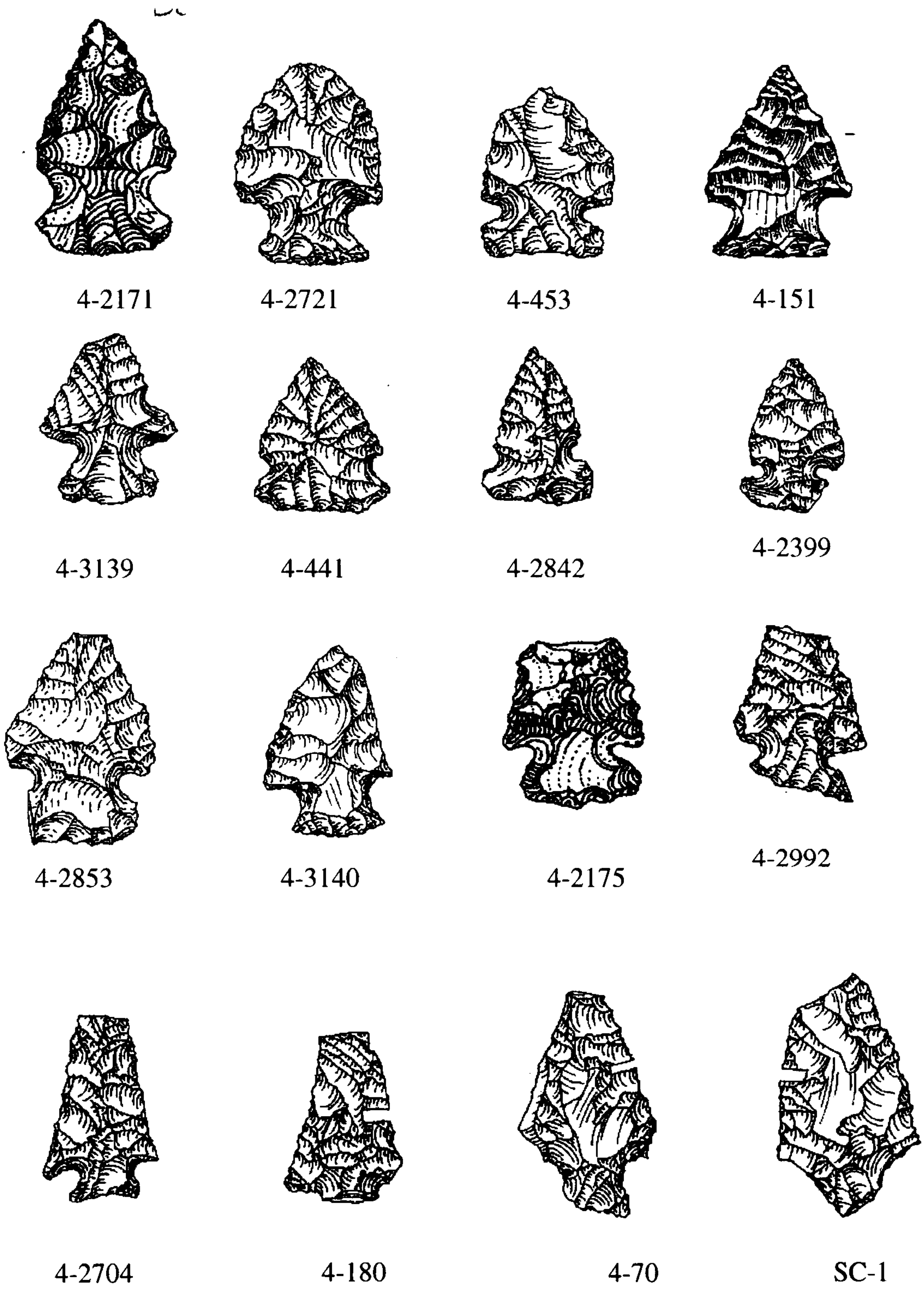
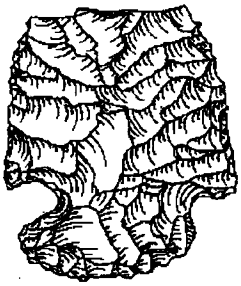


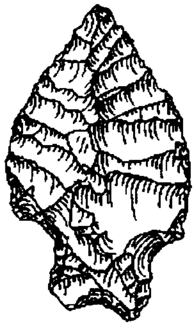
Figure 57: Dart Points From the North Santiam Subbasin.

4-461

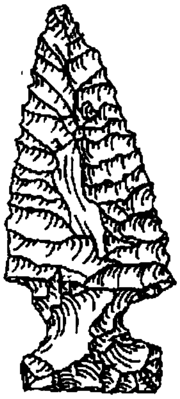


4-2861

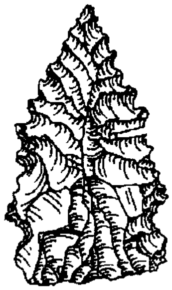
4-3029



4-373



4-2978



4-60

4-421

4-2780

4-2439

4-3263

4-530

4-491

Figure 58: Dart Points from the North Santiam Subbasin.

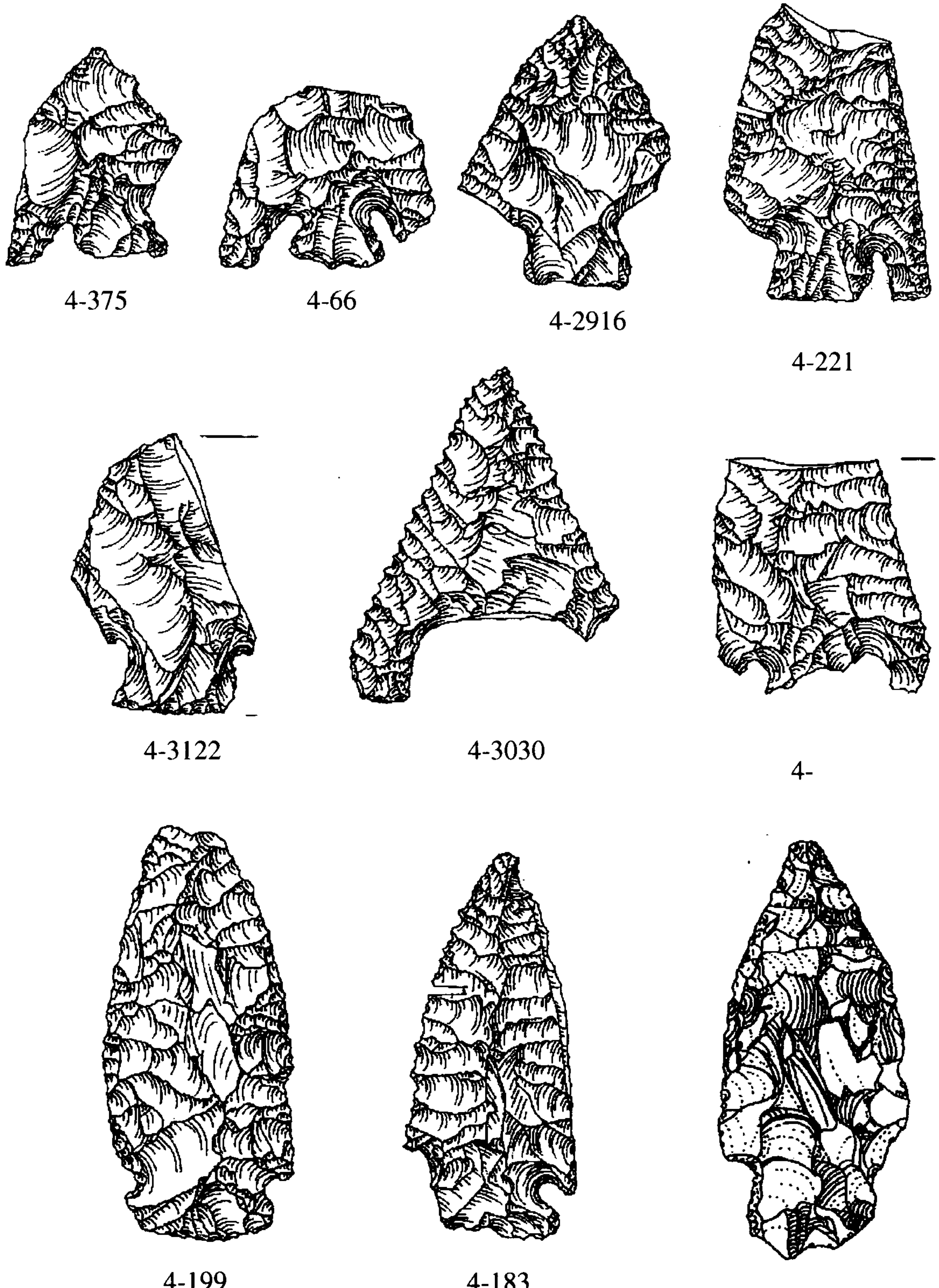


Figure 59: Dart Points from the North Santiam Subbasin.

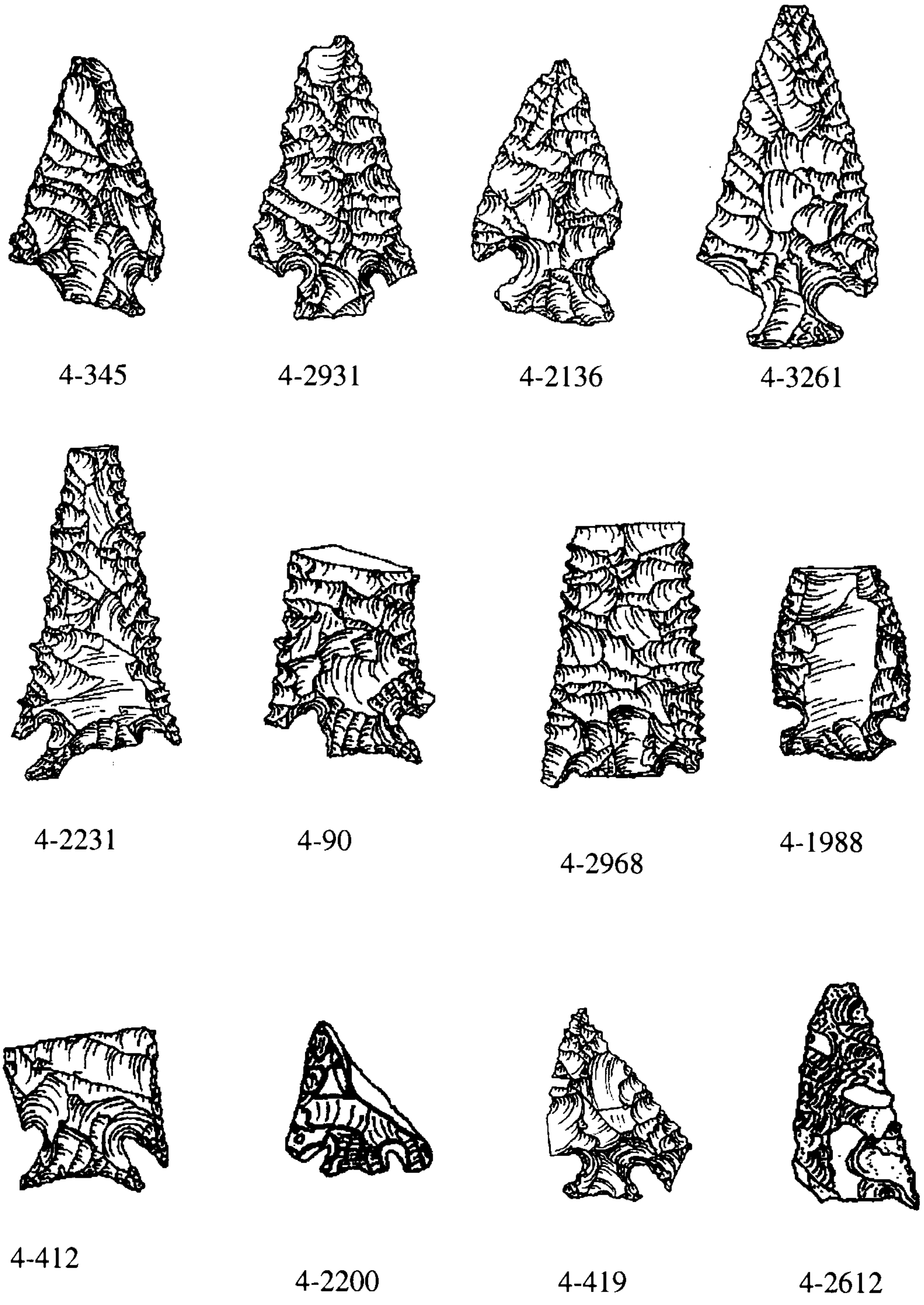


Figure 60: Narrow Neck Projectile Points from the North Santiam Subbasin.

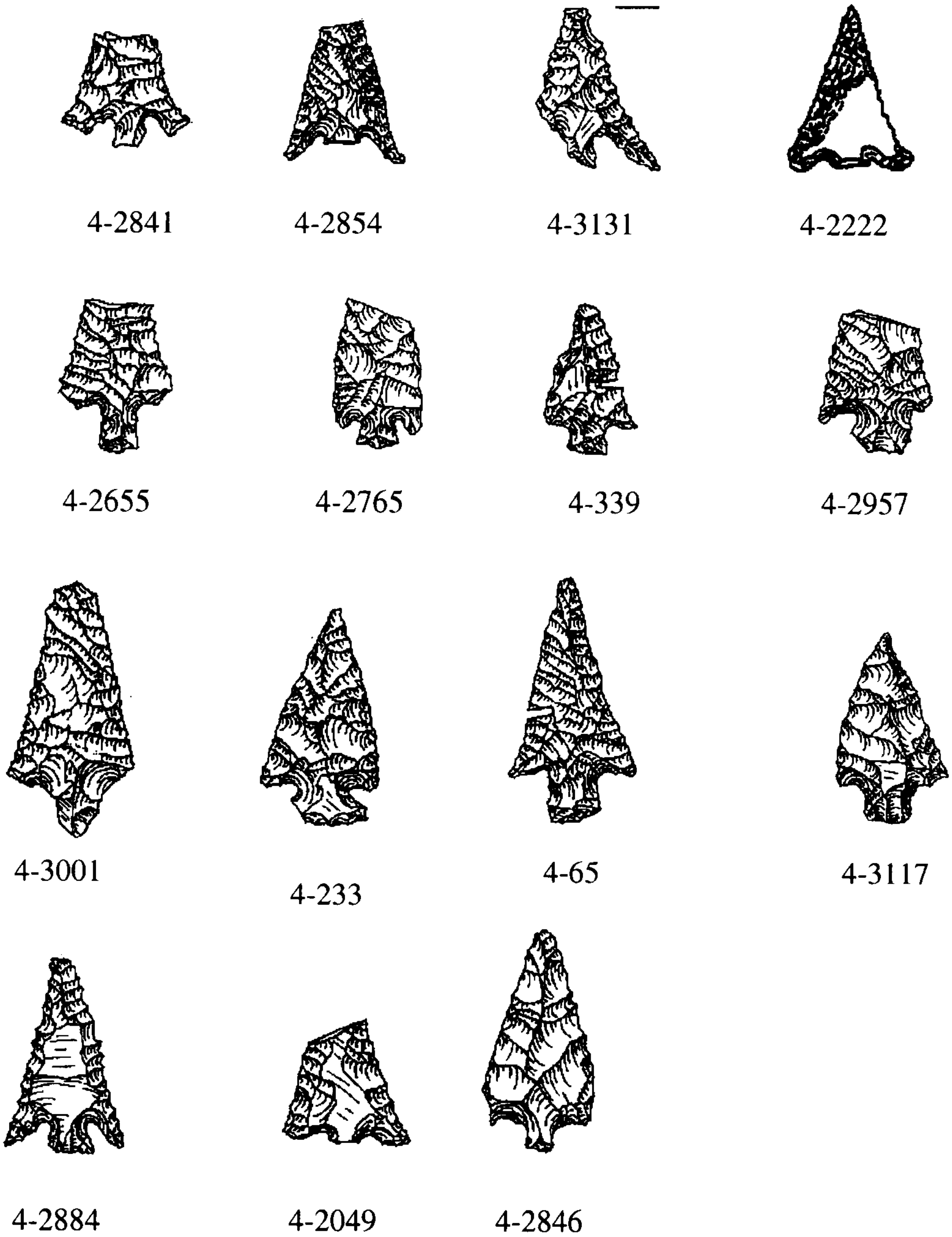
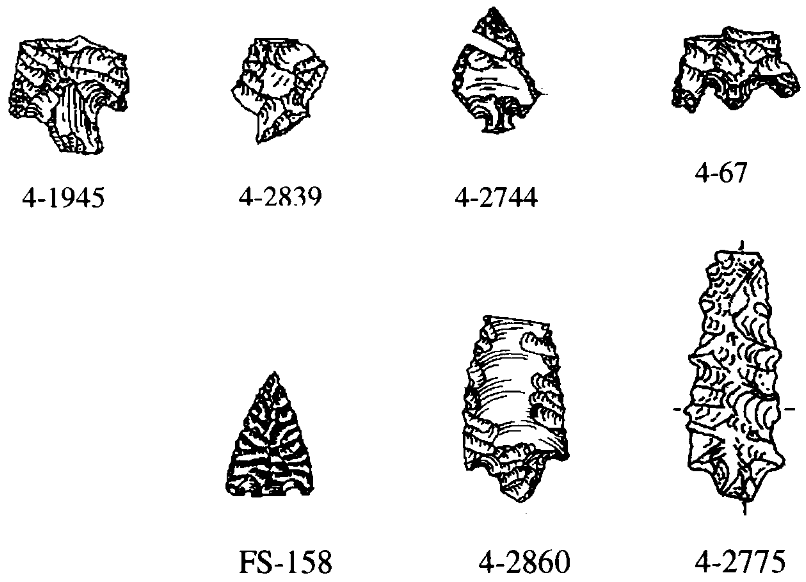


Figure 61: Narrow Neck Projectile Points from the North Santiam Subbasin.



Appendix B
Oracle Database Forms

WILLAMETTE NATIONAL FOREST
CULTURAL RESOURCES ORACLE DATABASE
LITHIC TOOL CODING FORM (1 PER TOOL)
(left justify entries)

Site Number: _ _ -- _ _ _ _ _ Collect. Method: _ Repository:___ __
Provenience:
Ex_Level: _ _ _ _ _ _ _ _ Catalog No:__ __ __ __ __ __ __ __ __ __ __

Catalog Type:
Raw Material: _ _ _ _
Raw Material Color: _ _

Tool Integrity: _

Length:
Width: _ _ _
Thickness: _ _ _
Neck Width: _ _ _ _
Heat Treatment: _
*Heat Damage: _ , _ , _ , _ ,
*Edge Shape: _ , _ , _ , _

*Use Wear: _ , _ , _ , _

Obsidian Source:
Mean Hydration:

Biface Form: __ __
Biface Stage:__

Projectile Point:
Form:___
Base:__ , __
*Margin: _ , _ , _ ,

Core Type:___
Groundstone Type:__ __
Groundstone Wear: __

Parent Artifact:__ __ __ __ __ __ __ __ __ __ __ __ __ __ __ __ __

* multiple responses possible

Catalog Type:
02 = Biface/biface fragment
09 = Cobble tool/fragment
11 = Core/fragment
12 = Debitage
26 = Projectile point/fragment
28 = Retouched flake
34 = Utilized flake
35 = Groundstone/fragment

Raw Material Type:
BAS = Basalt
CCS = CCS
CHAL = Chalcedony
CHRT = Chert
JSPR = Jasper
OBS = Obsidian
PEW = Petrified wood
PUM = Pumice
QRTZ = Quartzite
UIGN = Unknown igneous
USED = Unknown sedimentary

Raw Material Color:
01 = Beige or tan
02 = Black
03 = Blue

Use Wear:
1 = Arriss abrasion
2 = Crushing
3 = Microflaking

Obsidian Source:
01 = Cougar Mtn.
02 = Devil Point
03 = Glass Buttes

04 = Brown
05 = Green
06 = Greenish black
07 = Grey
08 = Pink
09 = Purple
10 = Red
11 = Reddish brown
12 = Varied/multiple
13 = White
14. Yellow

4 = Polish
5 = Sheen
6 = Striations
7 = Impact fracture

04 = Inman Creek Gravels-A
05 = Inman Creek Gravels-B
06 = McKay Butte
07 = Newberry Volcano
08 = Obsidian Cliffs
09 = Quartz Mountain
10 = Silver Lake/Sycan
11SpodueMountain
12 = Winberry Creek
99 = Unknown

WILLAMETTE NATIONAL FOREST
CULTURAL RESOURCE DATA CODING FORM

REFERENCE INFORMATION:

NUMBER _ _ _ _ _ _ _ _ _ _ _ _ Temporary Forest number

NAME
Name assigned by District to cultural property

TRINOMIAL _ _ _-_ _ _ _ _ _ _ _ _ _ Smithsonian Trinomial
or SHPO Trinomial

****

LOCATIONAL INFORMATION

Ranger **DISTRICT** __ 1 = Clackamas 4 = Lane
COUNTY _ 2 = Douglas 5 = Linn
Land **OWNERSHIP** __ 3 = Jefferson 6 = Marion

TOWNSHIP _ _ _ _ _ S **RANGE** _ _ _ _ _ E

SECTION _ _ **Q-SECTION** _ _ **QUAD**

UTM EAST _ _ _ _ _ _ _ **UTM NORTH**

ELEVATION _ _ _ _ _ _ **TRI**

****

ENVIRONMENTAL INFORMATION

LOCAL LANDFORM _ _

01 = Bench
02 = Cave/Rockshelter
03 = Knoll/Knob
04 = Lakeshore
05 = Lava Field
06 = Meadow/Mire
07 = Peak

GENERAL LANDFORM

01 = Floodplain
02 = Lake Basin
03 = Midslope
04 = Plateau
05 = Stream Confluence
06 = Stream Headwaters Basin
07 = Toeslope

08 = Ridgeline	(Alluvial/Colluvial fan)
09 = Rock Outcrop/Talus	08 = Topslope
10 = Saddle	(Crest, Ridge, Saddle)
11 = Slope	
12 = Stream Terrace	

SLOPE __ __ **ASPECT** _ __ **SOIL**

VEGETATION: Circle the code(s) for ethnobotanical vegetation present within the general area (400 meter radius) of the cultural property.

01 = Needs update	23 = Orchids
02 = Alder	24 = Oregon grape
03 = Bear grass	25 = Ponderosa pine
04 = Blackberry	26 = Raspberry
05 = Bracken fern	27 = Rhododendron
06 = Bunchberry	28 = Rose
07 = Camas	29 = Salal
08 = Cedar	30 = Salmonberry
09 = Chinquapin	31 = Serviceberry
10 = Chokecherry	32 = Skunk cabbage
11 = Currant	33 = Sorrel
12 = Douglas fir	34 = Strawberry
13 = Elderberry	35 = Sword fern
14 = Fireweed	36 = Thimbleberry
15 = Hemlock	37 = Thistle
16 = Horsetail	38 = True lilies
17 = Huckleberry	39 = Vine maple
18 = Kinnickinick	40 = Wild plum
19 = Manzanita	41 = Willow
20 = Miners lettuce	42 = Wocas (Pond lily)
21 = Oak	43 = Yarrow
22 = Ocean spray	44 = Yew

WATER SOURCE __ Nearest source of water to the cultural property.

1 = Spring/Seep	6 = Lake/Pond
2 = Class I Stream	7 = Marsh/Mire/Bog
3 = Class II Stream	8 = Canal/Ditch
4 = Class III Stream	9 = Reservior
5 = Class IV Stream	

WATER DISTANCE __ __ __ __ meters **WATER DIRECTION**

SUBDRAINAGE

LOCAL SETTING _ _ **GENERAL SETTING**

01 = Clearcut
02 = Grass/Shrub
03 = Lodgepole
04 = Marsh/Swamp
05 = Meadow
06 = Mixed Conifers
(Douglas fir, et.al.)
07 = Ponderosa pine community
08 = Reprod plantation
09 = Riparian
10 = Rock outcrop/Talus
11 = Subalpine Parkland
12 = Selective harvest unit

****

CULTURAL INFORMATION

TYPE _

C = Cultural site
I = Isolated find
U = Unverified find

SIZE
Square meters

ARTIFACT _ _ _ _ _ _ _ _ _ _

_ _ _ _ _ _ _ _ _ _

_ _ _ _ _ _ _ _ _ _

_ _ _ _ _ _ _ _ _ _

_ _ _ _ _ _ _ _ _ _

_ _ _ _ _ _ _ _ _ _

ANT = Antler
BAS = Basalt
BON = Bone
CER = Ceramic
CCS = Cryptocrystalline silicate
ENA = Enamelware
GLA = Glass
LEA = Leather
MET = Metal
OBS = Obsidian
OTH = Other
PEW = Petrified wood
POR = Porcelain
PUM = Pumice
SHE = Shell
SED = Other sedimentary rock
WOO = Wood
UNK = Unknown

01 = Abrader
02 = Anvil
20 = Ammunition
21 = Bottle

03 = Awl/Burin	22 = Board (lumber)
04 = Biface	23 = Boot/footwear
05 = Chopper	24 = Can
06 = Cobble	25 = Food service
07 = Core	26 = Hardware
08 = Debitage (flakes)	27 = Insulator
09 = Fire-cracked rock	28 = Jar
10 = Grinding slab	29 = Metal Tool
11 = Groundstone	30 = Nail
12 = Hammerstone	31 = Ore Car
13 = Mano	32 = Rail
14 = Modified flake	33 = Sign
15 = Mortar	34 = Tack
16 = Ornament	35 = Trade item/bead
17 = Pestle	36 = Wagon
18 = Projectile point	37 = Wire
19 = Uniface	38 = Fragment
	39 = Fragment, burned
	40 = Other

FEATURE: Circle the code for any non-portable cultural materials observed on the cultural property. Multiple responses possible.

01 = None known	26 = Pictograph
02 = Adit	27 = Pond
03 = Barn	28 = Quarry
04 = Blazed trees	29 = Railroad grade
05 = Boiler	30 = Road
06 = Bridge	31 = Rock alignment
07 = Burial/grave	32 = Rock cairn
08 = Cave/rockshelter	33 = Rock ring
09 = Corral	34 = Rock wall (multi-course)
10 = Crib	35 = Sign
11 = Dam	36 = Stamping mill
12 = Dendroglyph	37 = Stockade
13 = Depression/pit	38 = Structure, log
14 = Ditch/canal	39 = Structure, pole-shake
15 = Dump/midden	40 = Structure, stud-frame
16 = Fence	41 = Tailings
17 = Fireplace only	42 = Telephone line
18 = Flume/chute	43 = Trail shelter
19 = Foundation only	44 = Trail/path
20 = Hearth	45 = Water mill
21 = Livestock trough	46 = Water tank
22 = Lookout	47 = Well/altered spring

23 = Lumber mill	48 = Other historic
24 = Peeled trees	49 = Other prehistoric
25 = Petroglyph	50 = Other structural

FUNCTION: Circle the code(s) for the inferred function of the cultural property. Multiple responses possible.

01 = Administration (USFS)	13 = Lumber mill
02 = Burial/cemetery	14 = Military
03 = Camp, CCC	15 = Mining claim
04 = Camp, RR logging	16 = Quarry
05 = Camp, general	17 = Recreation
06 = Camp, mining	18 = Religious/vision quest
07 = Dump/midden	19 = Transportation
08 = Grazing/ranching	20 = Water procurement
09 = Homestead	21 = Other prehistoric
10 = Lithic scatter	22 = Other
11 = Logging, horse	
12 = Logging, truck	

TIME: Circle the code for the cultural period represented by the cultural property. Depending on the level of analysis, choose the most precise code that applies. Multiple responses possible for multi-component sites only.

01 = Prehistoric, period not established
02 = Paleoindian (9000 BC - 6000 BC)
03 = Archaic, phase not established
04 = Early Archaic (6000 BC - 4000BC)
05 = Middle Archaic (4000 BC - AD 0)
06 = Late Archaic (AD 0 - AD 1750)
07 = Protohistoric (AD 1750 - AD 1825)
08 = Historic, period not established
09 = 1825-1905 Early historic to pre USFS
10 = 1906-1933 USFS to CCC era
11 = 1934-1946 CCC era to World War II termination
12 = Historic Native American
13 = Historic Chinese

****
****

MANAGERIAL INFORMATION

DISCOVERY DATE _ _ - _ _ -
month day year when the cultural property was initially discovered.

DISCOVERY MODE _ Method by which the cultural property was discovered.

1 = Overview	4 = Inventory survey (compliance driven)
2 = Informant	5 = Incidental find
3 = Reconnaissance survey (not compliance driven)	6 = Other

FOREST PLAN _ _ _ Land Allocation from Willamette NF Plan.

ACTION: Circle the code(s) for the recommended management direction for the cultural property. Multiple responses possible.

0 = No Action	5 = National Register nomination
1 = Site/isolate form update	6 = National Register removal
2 = Evaluation (Phase I - III)	7 = Interpretation
3 = Preservation/Avoidance	8 = Research Use
4 = Adaptive Reuse	

EFFORT: Circle the code for the management action(s) completed for the for the cultural property. Write date behind completed action.

00 = No Action	07 = Phase II testing NRHP test excavation
01 = Relocated	
	08 = Phase III testing Data recovery excavation
02 = Mapped (to scale)	
03 = Surface inventory	09 = Protection (sign,fence)
04 = Surface collection	10 = Stabilization
05 = Photographed	11 = Rehabilitation
06 = Phase I testing Exploratory excavation	12 = Restoration
	13 = Interpretation

ANALYSES: Circle the code for type(s) of analysis completed for the cultural property. Multiple responses possible.

01 = Botanical	07 = Obsidian Characterization (Sourcing)
02 = Bottle	
03 = Carbon 14	08 = Obsidian Hydration
04 = Ground Stone	09 = Soil
05 = Lithic Functional	10 = Tin Can
06 = Lithic Stylistic	11 = Zoological
07 = Lithic Technological	12 = Other

MONITOR _ _ - _ _ -

month day year on which the latest formal monitoring of the condition of the cultural property was completed.

CONDITION: Circle the code(s) for the physical condition of the cultural property as evaluated by the latest visit. Multiple responses possible.

00 = Unknown	06 = Partially or fully excavated
01 = Collapsed	07 = Removed
02 = Disturbed, major alteration	08 = Standing/useable
03 = Disturbed, extent unknown	09 = Vandalization/theft
04 = Intact, minimal disturbance	10 = Weathered/eroded
05 = Inundation	

INTEGRITY _ present degree of surface integrity of the cultural property.

1 = High (76 to 100% intact)	3 = Low (0 to 25% intact)
2 = Average (26 to 75% intact)	4 = Unknown (not enough data)

IMPACT: Circle the code(s) for present impacts to the cultural property. Multiple responses possible.

01 = None Apparent	10 = Permittee Development
02 = Animal Use (also grazing)	11 = Recreation Use
03 = Blowdown	12 = Road/Bridge Construction
04 = Demolition	13 = Road Maintenance
05 = Facilities Development	14 = Severe Weathering/Erosion
06 = Fire Suppression	15 = Timber Harvest
07 = Inundation	16 = Vandalism/Illegal Collection
08 = Mining	17 = Water Development
09 = ORV Use	18 = Other

PROTECT: Circle the code(s) for the recommended protection measures that the cultural property needs to mitigate present impacts. Multiple responses possible.

00 = Insufficient Data	07 = Monitor every year
01 = Anonymity/ Avoidance	08 = Permanent Closure
02 = Documentation	09 = Rehabilitation
03 = Electronic monitoring	10 = Restoration
04 = Evaluation	11 = Seasonal Administrative Closure
05 = Maintenance	12 = Sign/Patrol
06 = Monitor every 5 years	13 = Stabilization

NRHP STATUS

Cultural property status relative to National Register criteria.

1 = **Undocumented** = location of cultural property is known or suspected but has not been recorded or verified.
2 = **Potentially Eligible** = has not been evaluated against the National Register criteria.
3 = **Not Eligible** = has been evaluated and does not meet the National Register criteria.
4 = **Eligible** = has been evaluated and does meet the National Register criteria.
5 = **Nominated** = has been nominated for listing on the National Register.
6 = **Listed** = has been listed on the National Register.

LE STATUS _ Current Law Enforcement Status of the cultural property. Higher codes subsume lower codes.

1 = Suspected Illegal Collection
2 = Incident Report
3 = ARPA Investigation (surveillance, damage determination, legal proceedings)
4 = ARPA Conviction

Appendix C
GIS Steps

To begin the GIS analysis I first needed to set my analysis environment.

1) First, I needed to set my analysis properties to allow me to clip a larger DEM grid to a smaller area of interest, which is the boundary of the Detroit Ranger District.

2) To clip the larger DEM:

    a. With the **elev10** active, but not turned on click on analysis menu, choose properties. Set the analysis extent "same as **de_bnd**" (polygon theme not grid). Click ok.

    Any grids created using map calculator or queries will have the same extent as the **de_bnd theme**.

    b. From the Analysis menu, choose map calculator. Double click on **Elev10** and then evaluate.

    When you click evaluate, Arcview Spatial analyst will create a new elev grid with values identical to those of the existing **elev10** grid but clipped to the extent of the **de_bnd** theme.

    A new Map Calculation 1 theme will be added to the view. Make Map Calculation 1 them active and open he theme properties and change its name to **elev_clp**.

    The **elev_clip** will have the same extent as the **de_bnd** polygon. However, the **elev_clip** is a rectangle and the **de_bnd** is not. In order to conduct the GIS analysis within the boundary of Detroit Ranger District those areas outside of the boundary need to be excluded.

3) To exclude these areas an analysis mask needs to be created using the boundary of Detroit RD. The **de_bnd** theme is the coverage I want to use to make the mask, however all spatial analysis is done in the raster environment, so I needed to covert the de_bnd polygon theme to a grid.

    c. To do this, I made the de_bnd theme active, from the theme menu, I choose covert to Grid. In the Convert **de_bnd** dialog, I changed the name to **bndry**, in the conversion extent dialog box: I set the output grid to same as de_bnd.shp. I set the cell size to 10 and clicked OK. At the prompt to join feature attributes to grid, I clicked No. Clicked yes to add theme to view.

    With the new grid bndry highlighted I clicked on theme, properties, and changed the name to **Boundary Mask**.

    d. From the analysis menu, chose properties to open the analysis properties dialog. (The analysis extent drop-down list displays "current value" – the extent of the de_bnd set previously). From the analysis Mask drop-down list, choose "**Boundary Mask**" and click ok.

This now allows me to mask the areas outside of the Detroit boundary from the **Elev_clp** grid (which is rectangular in form).

e. From the analysis menu, choose map calculator, in the dialog, double-click on the **Elev_clp** layer to add it the expression box. The out put grid will have the same values as the elev_clip grid. Except that it will have No Data values where the mask grid has No Data. Click evaluate.

   When Map calculation 1 theme is added to the view make it active and in the theme properties, change its name to **Elevation Detroit**. Click ok.

Elevation Detroit is a grid theme that has elevation values corresponding to the boundaries of the Detroit Ranger District.